PICKING THE BONE:

THE B-1 BOMBER AS A PLATFORM FOR INNOVATION

BY

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APPROVAL

The undersigned certify that this thesis meets masters-level standards of research, argumentation, and expression.

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DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.

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ABSTRACT

In the early 1990s, the United States Air Force envisioned the need to change the mission and technological capabilities of its strategic nuclear bomber, the B-1B. The result was transformational. This study uses Stephen P. Rosen's theoretical model of military innovation to explain how the B-1 weapon system, one of the United States' long-range bombers, transformed into an effective weapon system for irregular war within the context of the Global War on Terror (GWOT). The B-1's transformation was organizational, cultural, and technological. As a result, a weapon system designed as a nuclear bomber changed into an effective conventional platform and then again into a platform successful in supporting irregular warfare. The study provides a contemporary case study of military innovation tested against the theory of Rosen's intra-service military innovation model. It intends to better understand and document what enabled and what inhibited the transformation of the B-1 weapon system during the relative peacetime environment of the 1990s and during the wartime setting after 2001.

CONTENTS

Introduction

> *Employed properly, airpower (to include air, space, and cyberspace capabilities) produces asymmetric advantages that can be effectively leveraged by joint force commanders in virtually every aspect of irregular warfare.*
>
> *-- T. Michael Moseley, General, USAF*

In his 1991 book *Winning the Next War: Innovation and the Modern Military*, Stephen P. Rosen proposes a theory of innovation that evaluates why and how military organizations make major changes in the way they fight. He questions whether it is easier to innovate in peacetime or during wartime. He also explains how technological innovation in the military differs from the innovation that changes the way a military organization fights. His study provides a foundation for analysis and provides conclusions about the role of resources, intelligence, and civilian control in military innovation. His conclusions aided American leaders concerned with military innovation in the 1990s. Shortly after Rosen introduced his theory of innovation, the United States Air Force envisioned the need to expand its strategic nuclear bomber's mission and capabilities. After 1991, the United States experienced nearly ten years of relative peacetime followed by nearly ten years of significant wartime operations. During those periods of peacetime and wartime operations, the B-1B weapon system, which includes the aircraft, the organizations, the military service members that fly and fix it, and the Air Force leaders who direct its missions, underwent a transformation in the way it was expected to fight, while also undergoing significant technological modifications. Elements of Rosen's peacetime, wartime, and technological innovation theory collectively help explain the B-1 weapon system's challenging transformation.

This study uses the Rosen theoretical model of military innovation to explain how the B-1 weapon system, one of the United States' long-range bombers, transformed into an effective weapon system for irregular war. The B-1's transformation was organizational, cultural, and technological. As a result, the outcome changed the weapon system designed specifically as a nuclear bomber into an effective conventional platform and then again into a

platform that successfully supported irregular warfare. Political, organizational, financial, and technological obstacles opposed the transformation. Specific questions this study attempts to answer are: What drove, enabled, or inhibited the change? How did the Air Force transform the B-1, designed as a strategic nuclear bomber, into an effective instrument for irregular warfare? Finally, what are the lessons learned and the strategic implications for the future?

The study attempts to explain how the military adapts existing Air Force equipment, training and doctrine to changing service roles and missions. It highlights the need for flexible, learning organizations within the military during peacetime, and more importantly, during wartime. The study provides a contemporary case study of military innovation examined using the theory of Rosen's intra-service military innovation model. It intends to better understand and document the enablers and inhibitors to the transformation of a weapon system during the relative peacetime environment of the 1990s and the wartime setting after 2001.

For this thesis, military innovation is change: altering doctrine, tactics, technology, or organizational structure with the intent of better achieving objectives. The organization's intent to improve its outcomes is important to this definition. Change is initiated toward or for a specific purpose. Equally important is the implication of change taken on behalf of an organization or military unit. Though the idea or stimulus for the change may originate outside the organization, the organization itself must implement the change as a collective.

By examining the changes to doctrine, training, tactics, and technology in the B-1 force during periods of peacetime and wartime, key events or patterns in the mechanism at work can be understood. Understanding the forces enabling change, as well as those that inhibit it, can inform successful reconfigurations in future conflicts.

Since the weapon system's inception, the B-1 has been at the heart of a political, doctrinal, and technological controversy concerning nuclear weapons and strategic bombing. Residual effects of this controversy remain today

despite a decade of continuous and effective combat deployments supporting Operations Enduring and Iraqi Freedom, as well as other conventional missions throughout the world. Nevertheless, the B-1 and its crews maintain a solid reputation for flexibility and success in conventional and irregular war.

The process of transformation began well before B-1 aircrews flew the first missions in Afghanistan in 2001. The technological and cultural transformation gained momentum in 1994 when the commander of Air Combat Command, General Michael Loh, implemented the Conventional Munitions Upgrade Program (CMUP) to compensate for an assessed gap in US conventional-strike capability. During the transformation process, proponents for the aircraft, primarily a select group of senior military leaders, congressional representatives, and B-1 aircrews, sought to re-establish B-1 relevancy and combat roles in the wake of a changing military landscape.

Making the weapon system effective in irregular war required technological, doctrinal, and organizational innovation. The aircraft avionics, weapons, sensors, and training were modified to support the role of armed reconnaissance, close air support, and non-traditional ISR. Although the airframe and engines were not significantly changed throughout this process, the modifications to weapons, avionics, tactical training, and missions were substantial when compared to the original configuration of the aircraft as it performed the nuclear mission during the previous decade. Operation Allied Force marked the completion of the first phase; the weapon system had been transformed into a capable conventional bomber. Following Allied Force, flying the B-1 was a different experience for the new generation of B-1 aircrew trained in conventional weapons and tactics; they operated in a different organizational culture than what the handpicked aviators chosen to fly the newest nuclear bomber in the earlier years experienced. In October of 2001, when the first wave of B-1 crews deployed from the United States to strike Taliban targets in Afghanistan, a new role for the B-1 was just emerging. During the period from 2001 until 2009, the B-1 weapon system not only changed significantly with respect to its avionics and weapons technology, but it also experienced a significant shift in tactics and mission roles as it responded to changing

military strategy and measures of effectiveness. This thesis is divided into five sections, an introduction, a conclusion, and three main body chapters that provide an historical narrative of the weapon system and highlights events and Air Force leaders effecting the transformation. We will start with a primer on Rosen's model for military innovation.

Chapter 1 provides historical background on B-1 development. It demonstrates the controversy and political infighting of the Department of Defense, Congress, and the public. Even as a nuclear bomber, the B-1 shifted in its design from a high-fast penetrator, to a low-level, low-observable, radar-based platform. This transformation marked the first technological shift in the lifespan of this weapon system.

Chapter 2 discusses peacetime innovation in the B-1 weapon system. It documents the shift in organizational culture and the technological modifications that occurred during a relative peacetime environment as the B-1 community changed from nuclear to conventional missions under the direction of General Michael Loh, Commander, Air Combat Command. The conventional munitions upgrade program set the stage for the B-1 to integrate with the Combat Air Force prior to the wartime changes required to make the B-1 effective in irregular warfare. Changing organizations, missions, and employment methods resulted in a new culture. Also influential was the opening up of the USAF Weapons School to bomber aircraft and aircrew. The chapter also describes what was learned from the B-1 community's first and second combat experiences during Operations Desert Fox and Allied Force.

Chapter 3 discusses the wartime innovation in the weapon system that occurred as it adapted to remain effective in the various phases of the Global War on Terror. It provides accounts of the aircraft from squadron commanders, weapons officers, and other military leaders from 2001 until 2009. The chapter shares the observations and assessments recorded in official histories, reports, and personal interviews. The narrative highlights the changes in capabilities to the aircraft and explains innovation as measures of effectiveness

shifted in response to the changing strategic environment in Afghanistan and Iraq.

The conclusion of this study offers analysis and insight through the lens of Rosen's theory. Because Rosen's model of innovation is tested against the B-1 case study, it is important to review his theory. Rosen's theory of innovation poses questions concerning the conditions in which military innovation takes place.[1] He observes that each service has its own allure and distinct way of thinking about the way war should be waged. Rosen agrees that military organizations can innovate independently and he proposes that the impetus for reform comes from within the organization. He argues that civilian intervention is not required and that it generally fails. He agrees that military organizations are stimulated by changes in the security environment, but he believes that innovation results when branches of the same service vie to become their service's dominant guarantor of security. When their capabilities overlap, competition arises, and senior military leaders both encourage and moderate the competitive ideas. Innovation results when an emerging war-fighting concept gains support among senior military leaders and then is endorsed by civilian leaders.

Rosen asserts that peacetime innovation requires "product champions" – senior officers who advocate innovative approaches to warfare and open promotion paths for other reformers. He argues that peacetime innovation is most likely and easiest. Rosen concludes that senior military leaders hold the key to peacetime innovation because they have the best opportunity to change civilian and military leaders' minds concerning weapon-system procurement and sustainment. He also concludes that peacetime innovation has been possible when senior military officers, with traditional credentials, react not to intelligence about the enemy, but to a structural change in the security environment.[2] His theory suggests that peacetime military innovation occurs when respected senior military officers formulate a strategy for innovation that

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[1] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, (Ithaca, NY: Cornell University, 1991).
[2] Rosen, *Winning the Next War*, 251.

has intellectual and organizational components. He suggests that leaders must translate their vision for the new way of war into concrete tasks and measures of success that are performed every day, in peace and war.

Rosen then outlines a theory for wartime innovation. He recognizes that everything is different in wartime. Innovations must be thought through and implemented within two or three years to be of any use, which makes wartime innovation very difficult.[3] He states that wartime innovation relies upon the amount of organizational learning that can take place under the unique conditions of war. Although constraints exist, opportunities for innovation also continue because both old and new innovative methods can be tested and compared in combat. A major innovation according to Rosen is, by definition, unprecedented. Even if the innovation takes place in wartime, the military has little time to adapt it to wartime. Rosen then argues that wartime innovation, as opposed to reform, has been most effective when associated with a redefinition of the measures of strategic effectiveness employed by the military organization. He argues that it has been limited by the difficulties connected with wartime learning and organizational change, especially with regard to the time constraints of war.[4]

Finally, Rosen's theory on technological innovation states that it is not closely linked with either intelligence about the enemy, or with reliable projections of the cost and utility of alternative technologies. Instead, the problems of choosing new technologies are best accomplished when senior leaders treat them in terms of managing uncertainty when assessing perceived future wartime requirements.[5]

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[3] Rosen, *Winning the Next War*, 34.
[4] Rosen, *Winning the Next War*, 35, 251. The definition of the strategic goal, the relationship of military operations to that goal, and indicators of how well operations are proceeding can be thought of as a strategic measure of effectiveness for the military organization. When military innovation is required in wartime, it is because an inappropriate strategic goal is being pursued, or because the relationship between military operations and that goal has been misunderstood. The old ways of war are employed, but no matter how well they are executed, the war is not being won. A new strategic goal must be selected and a new relationship between military operations and that goal must be defined.
[5] Rosen, *Winning the Next War*, 252.

The story of the B-1's innovative change from a nuclear bomber to a conventional bomber fits within Rosen's peacetime explanations. Rosen's wartime innovation ideas help explain the B-1 weapon system's experience as it adapted to irregular warfare tactics and measures of effectiveness after 2001. The B-1 case study illustrates a good part of Rosen's theory; it illustrates how innovation should strive to add flexibility to military organizations and weapon systems. Additionally, the study proposes that a weapon system may gain credibility in wartime and garner support and funding from senior leaders to enable more innovation.

Chapter 1

BONE OF CONTENTION

I have directed the Secretary of Defense to revitalize our bomber forces by constructing and deploying some 100 B-1 bombers as soon as possible…
President Ronald Reagan, 2 October 1981

Under the Reagan administration's "two bomber" plan, the B-1 aircraft is intended to serve as a penetrating bomber until the B-2 bomber is deployed in the 1990s.
-- U.S. Congressional Report on B-1 Enhancements

The Nation's Newest Strategic Nuclear Bomber

President Reagan's "as soon as possible" charge mobilized the aircraft industry with a revitalized sense of urgency to build "the most capable bomber ever produced to that date by any country in the world."[1] Historical records show the B-1 program received the highest priority ever accorded a new Air Force system during its development and production.[2] Because of the high priority placed on the program once production began, the first B-1 rolled out five months ahead of contract schedule, and under budget, on 4 September 1984. Just over three years later, in January 1988, the 100th and final aircraft produced rolled out of the assembly hangar at Rockwell International's North American Aircraft Operations, Palmdale, California plant.[3] The entire fleet of B-1 aircraft was developed and produced in six and a half years; the first aircraft delivered met the initial operational capability (IOC) requirements less than five years after the president gave the production go ahead.[4] Despite the impressive production accomplishments and the technical prowess of the B-1, it also earned the inauspicious distinction of being the most expensive and arguably the most controversial weapon system ever produced.[5] Political debate, competition for economic resources, and contending defense strategies drove the rhetoric of the B-1 procurement decision to extreme levels of

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[1] Maj Gen Elbert E. Harbour, USAF, Program Director for B-1 SPO, Foreword to William G. Holder, *The B-1 Bomber,* 2nd ed. (Blue Ridge Summit, PA: Tab Books Inc., 1988), vii.
[2] Holder, *B-1 Bomber*, vii.
[3] Holder, *B-1 Bomber*, vii.
[4] Holder, *B-1 Bomber*, vii.
[5] Nick Kotz, *Wild Blue Yonder: Money, Politics, and the B-1 Bomber,* (New York: Random House, Inc., 1988), Introduction.

passionate opposition and near-religious support. For many decades, its design and completion remained at the center of a political debate encompassing the efficacy of strategic nuclear bombers, expensive weapon systems, and the problematic technology upon which the nation placed its security.

This chapter briefly discusses the history of Air Force bomber procurements after World War II. It highlights the historical context and political controversy behind the design, production, and intended role of the B-1. Lastly, the chapter serves to introduce a few of the pivotal Air Force officers who experienced the transformation of the B-1 weapons system.

Air Force Bombers after WWII

Long before the Air Force became an independent service, airpower in the form of long-range strategic bombers was part of the national defense strategy. As the United States emerged from World War II, it possessed only a small number of atomic weapons, and bombers were the only method of delivery. Consequently, Army Air Force leaders built their drive for autonomy on strategic bombing. Only gradually did the nascent service recognize strategic bombing as only one of many unique capabilities of airpower.[6] For over 30 years the nuclear strike role and its doctrine dominated all planning, weapons development, procurement, tactics, and training for long-range bombers.[7] Furthermore, the manned bomber played a significant role in justifying an independent Air Force. Air Force leaders consistently promoted causes and advocated modern weapon systems supporting the longstanding role strategic bombardment played within the service.[8] The development, production, and procurement of new bomber weapon systems followed a continuous evolutionary process, reflecting the priority placed on one of the Air Force's core doctrinal beliefs and missions. As soon as a new bomber joined the fleet, a more advanced model – or two – appeared on Air Force drawing boards.[9] During the early post-war period, the United States developed the B-36, B-47,

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[6] Col Thomas E. Keaney, USAF, *Strategic Bombers and Conventional Weapons: Airpower Options*, National Security Affairs Monograph Series, (Washington, DC: National Defense University Press, 1984), 5.
[7] Keaney, *Strategic Bombers and Conventional Weapons*, 7.
[8] Frank P. Donnini,. *Battling for Bombers: The U.S. Air Force Fights for Its Modern Strategic Aircraft Programs,* Contributions in Military Studies, Number 195. (Westport, CT: Greenwood Press, 2000), 7.
[9] Donnini. *Battling for Bombers*, 5.

B-52, and B-58 bombers.[10] From the late 1950s through the early 1990s, the Air Force pursued four different aircraft as part of its strategic force modernization program: the B-70, the B-1A, the B-1B and the B-2.[11] The B-1 was the only aircraft designed as part of the nation's strategic force modernization program to enter operational service or stand nuclear alert until the B-2 reached IOC in 1992.

B-70 Valkyrie

The first strategic aircraft the Air Force sought after 1954 was the B-70 Valkyrie, designed as the long-range strategic bomber replacement for the B-52.[12] Under Curtis LeMay's leadership of SAC, the Air Force Systems Command commonly acquired two concurrent bomber aircraft programs until one of technologies or aircraft proved better than the other.[13] As the B-70 program grew, the Air Force made a concerted effort to produce another new long-range bomber, named the Aircraft Nuclear Propulsion (ANP). Both aircraft went far beyond existing state-of-the-art technology: the B-70 for its speed, flight ceiling, and wing design; and the ANP due to its nuclear power plant.[14] Both designs were ambitious; they intended to set the parameters for building US nuclear-armed bombers capable of flying "much faster, farther, and higher than had ever been conceived."[15] The ANP technology failed to progress into a clearly defined military requirement. This failure propelled the B-70 to the top development priority. Many considered the B-70 to be the manned-aircraft answer to the growing influence of land-based missiles beginning to come of age.[16] The Air Force intended to build 244 B-70s to replace the 660 existing B-52s.[17] Although the Valkyrie never went into full scale production, two test aircraft were built and flown until one crashed in 1967. The remaining model was retired shortly afterwards.

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[10]Alton H. Quanbeck and Archie L. Wood with the assistance of Louisa Thoron. *Modernizing the Strategic Bomber Force: Why and How*. Studies in Defense Policy, (The Brookings Institution, 1976), Introduction, 59.
[11] Donnini, *Battling for Bombers*, 4.
[12] Donnini, *Battling for Bombers*, 21.
[13] Donnini, *Battling for Bombers*, 21.
[14] Donnini, *Battling for Bombers*, 19.
[15] Kotz, *Wild Blue Yonder,* 30.
[16] Donnini, *Battling for Bombers,* 21.
[17] Donnini, *Battling for Bombers*, 40.

The political environment during the procurement of the B-70 did not support a costly new strategic bomber program for two reasons. The first was presidential policies toward strategic defense, and the second was the Soviet Union's successful interception of Francis Gary Powers' U-2 spy plane using a surface-to-air missile (SAM). President Eisenhower's policies toward strategic defense gave no allowance for the expensive B-70. Instead the president supported intercontinental ballistic missiles which were emerging as a more cost-effective technology for nuclear weapons delivery.[18] The second strategic defense program favored by Eisenhower was the development of an air defense system protecting the United States and Canada. The president did not see a need for a new high-risk-technology bomber such as the B-70. Moreover, interception of the US spy plane caused a significant shift in nuclear penetration tactics and doctrine for strategic bombers. Since high altitude bombers were now considered vulnerable, strategists in the Department of Defense and the Air Force had to rethink the desired capabilities of new bombers.

As President Kennedy took office in 1961, the B-70 program was in a test-and-development status.[19] Defense Secretary Robert McNamara used his systems analysis methodologies to oppose the B-70 program on a cost-benefit basis—urging the administration to terminate the costly program.[20] A political tug of war involving congressional funding and military policy ensued between the old bomber warriors, LeMay and General White, on one side and the defense intellectuals, McNamara and his "whiz kids," on the other.[21] The political battle over the B-70 forced President Kennedy and Secretary McNamara to duel against the Air Force and its supporters in the legislative branch over who should control military acquisition policy. In the end, the president won through the persuasive logic of superior facts and analysis.[22] The first B-70 test flight occurred in late 1964, four years later than planned and nine years since the first contract was issued. The B-70 program lasted

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[18] Donnini, *Battling for Bombers*, 23.
[19] Donnini, *Battling for Bombers,* 24.
[20] Donnini, *Battling for Bombers,* 24.
[21] Donnini, *Battling for Bombers,* 24.
[22] Donnini, *Battling for Bombers* , 25.

from 1954 through the late 1960's, during that time, the political environment made the survival of any new weapon system difficult; it was especially so for an advanced technology system such as the B-70. The Air Force blamed stingy congressional fiscal policies for many of the aircraft's problems, while opponents blamed the Air Force's concurrent acquisition methods for diverting focus and funding to other programs. In the end, pressure politics, fiscal realities, and overly optimistic demands on technological development proved the bomber generals' hopes for the new aircraft unrealistic.

Even before the B-70 aircraft's development and subsequent cancellation, the Air Force sought to design and produce a completely new strategic bomber as an alternative. Early studies for the alternative aircraft design used names describing performance concepts and requirements and were referred to by the acronym of each particular study. Examples included the Subsonic Low Altitude Bomber (SLAB), the Extended Range Strike Aircraft (ERSA), and the Low Altitude Manned Penetrator System (LAMPS).[23] In light of the U-2 shoot down and developing missile technology, the LAMPS design name indicated a shift in Air Force requirements, demanding a bomber capable of low-altitude penetration through Soviet air defenses. Eventually, the Air Force honed design requirements into a specific type of aircraft, and by 1964 the approved concept earned the name Advanced Manned Penetrating Strategic System (AMPSS), which was later shortened by the Air Force to Advanced Manned Strategic Aircraft (AMSA).[24]

Some satirically dubbed the AMSA project "America's Most Studied Aircraft."[25] The initial study phase was unusually long for two reasons: the first was that the Air Force did not want to run into the problems of the B-58 and XB-70. Second, and more important, Secretary McNamara preferred a nuclear-missile force for deterrence rather than bombers.[26] In testimony before Congress, Secretary McNamara justified his 1966 postponement of AMSA

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[23] Donnini, *Battling for Bombers,* 50.
[24] Donnini, *Battling for Bombers,* 4.
[25] Major General Abner B. Marti, "The B-1: Strategic Deterrence into the Twenty-First Century," *Air University Review,* March-April 1976. http://www.airpower.maxwell.af.mil/airchronicles/aureview/1976/mar-apr/martin.html
[26] Keaney, *Strategic Bombers and Conventional Weapons*, 19.

development by stating the "strategic missile forces for 1967-71 will provide more force than is required for 'Assured Destruction' … a new advanced strategic aircraft does not at this time appear justified."[27] Secretary McNamara offered a more cost-effective solution. He believed the F-111 could fill the perceived bomber void as an interim transition to an ICBM force. The modified fighter idea became the FB-111 solution. The idea was to couple an F-111 modification program with the Short Range Attack Missile (SRAM) development program. Congress agreed with Secretary McNamara and allocated $210 million in fiscal years 1966 and 1967 to fund the development of the FB-111 SRAM program.[28]

With a new president came new administrative policies and a new strategic focus. In 1969 President Richard Nixon sought to extract the United States from Vietnam without simply pulling out in disgrace. He was also paradoxically motivated to maintain an advantage in the strategic-arms race while simultaneously trying to reach new arms-control agreements with the Soviet Union.[29] Moreover, President Nixon hoped to decrease arms spending, as he dealt with the immediate economic problems of inflation and rising unemployment.[30] He pulled troops out of Vietnam and expanded the air campaign into Laos and Cambodia in an effort to gain negotiating strength in hope of reaching a peace settlement with North Vietnam. The president also sought to strengthen US influence through increased diplomatic efforts with China and détente with the Soviet Union. Defense contractors, military leaders, and congressional committees could easily observe a changing political environment, domestically and internationally, with the new US president.

In his continued effort to strengthen American power, Nixon began modernizing nuclear capability. His appointment of Melvin R. Laird as secretary of defense and David Packard as deputy secretary was a shift in leadership culture from the McNamara years. Laird's top priority was to extract

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[27] Robert S. McNamara, US Secretary of Defense, "Strategic Bomber Program" Statement of Secretary of Defense before Subcommittee Number 2 of the House Armed Services Committee on The Fiscal Year 1967-71. 25 January 1966.
[28] Robert S. McNamara. US Secretary of Defense , "Strategic Bomber Program," 19. Total cost for the programs reached $8 billion in 1966 and $14 Billion in 1967.
[29] Kotz, *Wild Blue Yonder*, 89.
[30] Kotz, *Wild Blue Yonder,* 89.

the military from Vietnam, then to redirect the cost of the war toward modernizing strategic defense.[31] In March 1969, Laird directed a change to the Defense Department bomber plans to choose a "more appropriate solution for a longer term approach to the strategic bomber program."[32] This solution reduced the programmed acquisition of 253 FB-111As to 76. Laird claimed the FB-111 lacked the range and payload for strategic operations envisioned by the new administration. Laird also directed the acceleration of the AMSA design studies, claiming the B-52G and B-52H modifications were not in line with the long-term strategic focus.

Laird's understanding of congressional processes coupled with his expertise in the defense industry seemed like a positive omen for the struggling aerospace and defense industry. As the co-founder of the Hewlett-Packard Company, Packard was also an extremely successful executive and pioneer of computer technology. He understood the defense department well, freeing Laird to work the politics on Capitol Hill. Packard expected weapons to prove they met required design capabilities in research and development before they moved on to production.[33] Under Laird's and Packard's leadership, the Joint Chiefs of Staff regained control of weapon systems design, taking it away from the McNamara-established Office of Systems Analysis, controlled by civilian experts.[34] This opened the door for the Air Force to re-submit its bid for a new strategic bomber.

B-1A

In late 1969, after more than 300 aerospace industry and government studies, the Air Force officially opened the competition for the production contract of the AMSA design—now formally designated the B-1A.[35] The Air Force chose three defense firms as competitors for the prized contract: North American Rockwell, Boeing, and General Dynamics.[36] Because North American Rockwell lost the most recent contract for the Air Force's newest fighter, the

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[31] Kotz, *Wild Blue Yonder,* 90.
[32] Don Logan, *Rockwell B-1: SAC's Last Bomber* (Atglen, PA: Schiffer Military Aviation History, 1995), 13.
[33] Kotz, *Wild Blue Yonder,* 91.
[34] Kotz, *Wild Blue Yonder, 92.* The term used by the SECDEF at the time was "defined decentralization."
[35] Donnini, *Battling for Bombers*, 50.
[36] Kotz, *Wild Blue Yonder*, 94.

F-15, which was awarded to McDonnell Douglas Corporation of St. Louis, thousands of North American Rockwell employees lost their jobs to layoffs literally two days before Christmas of 1969.[37] North American Rockwell, known as a respected fighter-aircraft builder, was discouraged and nearly broke. The company almost pulled out of the B-1 competition, believing it could not compete with the likes of Boeing, the nation's premier builder of bombers and large commercial aircraft.[38] In a final effort to save the aircraft division of the company, a handful of engineers agreed to work for half pay to complete the B-1 proposal, which contained 75 volumes and 9,772 total pages by the time Rockwell submitted the bid for the competition.

The Air Force Source Selection Evaluation Board started in late 1969 and continued through the spring of 1970 to evaluate and score the submitted proposals. Scoring for the Air Force board rested on two basic factors: superior technical capability and cost.[39] Hundreds of Air Force officers began evaluating the technical details proposed by the three competitors. However, the decision to award the contract rested with Congress and the president, and their involvement promoted criticism that the decision was more political than requirement or merit-based. Laird and Packard believed any one of the companies could build the bomber, therefore the government's unstated policy of spreading contracts around to maintain the economic health of major defense contractors may have cast the deciding vote for the B-1A. Boeing, McDonnell Douglas, and General Dynamics each had lucrative and economically rewarding government contracts at the time—North American Rockwell was due for its share. The Nixon administration's decision to select Rockwell was indeed based, in part, on the economic need of the company. However, many still criticized the selection process as singularly political, claiming Rockwell received favorable treatment from the administration due to their significant presidential election contributions less than two years earlier.[40] The stage was

[37] Kotz, *Wild Blue Yonder*, 94.
[38] Kotz, *Wild Blue Yonder*, 94.
[39] Logan, *Rockwell B-1*, 20.
[40] Kotz, *Wild Blue Yonder,* 95.

set for one of the most hotly debated and intensively lobbied defense projects of the 1970s.[41]

Rockwell's new contract received funding in 1970 to build three prototypes and one ground test aircraft. In the 1976 defense budget, Congress funded an additional flight test aircraft as a pre-production prototype. The first flight was planned for April 1974. A decision for production would occur two years after the first flight test, and two years later the aircraft would be operational as a nuclear deterrent—standing alert for its nuclear mission of penetrating sophisticated Soviet defense networks. On 23 December 1974, the first B-1A prototype made its maiden flight from Palmdale, California, to Edwards Air Force Base (AFB). It was just one of many flight tests to occur over four years of the most comprehensive design and ground testing ever conducted in the development of a military aircraft. In less than a year, on 19 September 1975, the prototype bomber displayed its initial operating capability as a low altitude, high speed penetrator during another test flight at Edwards AFB.

Despite the successful flight-testing of the first B-1A prototype, Rockwell struggled to achieve the tremendous technical innovations demanded by the Air Force. Continually demanding technological capabilities that were beyond an evolutionary aircraft design process was part of Air Force organizational culture, service leaders at the time seemed driven to demolish all criticism that bombers were outmoded in the age of cheaper, faster, and less vulnerable intercontinental missiles.[42] Each Air Force 'desirement,' as some called the lofty design goals, translated to technical problems Rockwell had to solve before the aircraft could meet Air Force requirements. The Air Force did not want just another new airplane. The B-1 had to fly farther and faster than any other bomber, carry an unprecedented 40 tons of nuclear weapons, and deliver those weapons to the heart of the Soviet Union. In many ways the B-1 represented the vision of Strategic Air Command (SAC) and the bomber generals leading the Air Force: to keep the strategic bomber ethos alive amidst the emergence of an Air Force subculture advocating nuclear missiles or tactical nuclear delivery methods. As flight-testing moved further along, the technical challenges began

[41] Donnini, *Battling for Bombers*, 50.
[42] Kotz, *Wild Blue Yonder,* 111.

to take their toll through production delays and cost overruns.[43] If Rockwell could not solve the technical problems, or if the Air Force would not lower its expectations, they were in jeopardy of having the same problems as the B-58 and B-70 programs—each of those aircraft achieved dazzling supersonic speed, but the programs failed to solve some technical problems, high costs, or show their ability to perform the strategic mission successfully.[44]

The political debate over the B-1A escalated after President Richard Nixon resigned on 9 August 1974 amidst the Watergate scandal. Vice President Gerald Ford took office and retained James Schlesinger as his secretary of defense. Schlesinger was a tough-minded pragmatist not willing to tolerate a B-1A program with runaway costs.[45] Cost estimates for the acquisition program were early problems for the initial design studies and continued to plague the progress of the B-1A program after Rockwell won the operational test contract. Just as flight testing was getting under way, Schlesinger began reviewing total program costs. If Congress approved the Air Force request for 244 aircraft, the full contract would almost double the previous highest cost contract awarded for any weapon systems.[46] White House officials reported that Rockwell believed the program would cost more than $25 billion, while others in the Defense Department calculated costs could reach as high as $37 to $40 billion.[47] Because of rising cost estimates, technical challenges in the Air Force design demands, and continuous political controversy over the need for a new strategic bomber, the B-1A debate continued through the flight test stage in the mid-1970s.

Air Force Chief of Staff David Jones assumed command in 1974 amidst the Nixon presidential scandal and the B-1A design testing dilemma. General Jones understood Schlesinger's warning that support for the B-1 was not unconditional. Although Schlesinger supported strategic bombers because they appeared to cause the Soviets great worry and led them to spend billions on bomber defenses, he was determined not to sacrifice other military needs such

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[43] Kotz, *Wild Blue Yonder*, 110.
[44] Kotz, *Wild Blue Yonder,* 111.
[45] Kotz, *Wild Blue Yonder*, 118.
[46] Donnini, *Battling For Bombers*, 50.
[47] Kotz, *Wild Blue Yonder*, 96. See also: Congressional Budget Office, "U.S. Strategic Nuclear Forces: Deterrence Policies and Procurement Issues" (April, 1977), 36.

as fighters, close air support, and transportation for the infantry just to satisfy the Air Force's zeal for a high-tech bomber.[48] Schlesinger warned Jones that if B-1A program costs rose above $100 million per plane it would be too expensive to ward off congressional opposition. Jones was determined to find out exactly how much the B-1A program was going to cost. In December 1974, he gathered ten of the twelve four star Air Force generals to a secret meeting called Corona Quest to determine if the B-1A was worth the possible sacrifice of other Air Force weapons.[49] Jones charged his staff prior to the meeting to prepare detailed projections of the B-1A program costs, Air Force future budgets, and other weapon systems costs. Even the most optimistic projections threatened stopping projects already in production such as the A-10, F-15, and F-16. Although each general officer was enraged by the expected costs of the B-1A and the Air Staff's expected annual budget, by the end of the conference the Air Staff had readjusted the budget numbers and cost projections enough to unite each of the generals in continued support of the B-1A.[50] The strategic bomber remained at the core of Air Force identity, strongly enough to sacrifice spending on training and equipping the service in other mission areas. The Corona conference ultimately resolved to ease technological demands as a cost-saving measure, which drove compromises in the overall speed, escape system, and defensive avionics capability of the aircraft design.

Under President Ford's leadership, many segments of the country rallied around the bomber. The secretary of defense, the Joint Chiefs of Staff, and the Air Force continued to support the strategic bomber in light of growing concerns over the changing global situation and increasing strategic capabilities in the Soviet Union. The latest studies solidified the Defense Department's support for the B-1A, showing it as the most cost-effective and credible deterrent in the nuclear triad when compared to other options designed to match the Soviet threat.[51] Congressman Mahon of the House Appropriations Committee stated that US defense was the best in the world because his committee had recommended and the full Congress had approved funds

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[48] Kotz, *Wild Blue Yonder,* 119.
[49] Kotz, *Wild Blue Yonder,* 119.
[50] Kotz, *Wild Blue Yonder,* 120.
[51] Donnini, *Battling For Bombers*, 60.

whenever the Defense Department requested them for research and development.[52] The US Congressional Budget Office sent out a budget issue paper to raise public consciousness about the B-1A. It supported bomber modernization, claiming it was necessary to maintain the bomber leg of the nuclear triad, that America needed a new strategic bomber, and that the B-1A design requirements were in line with America's need.[53]

The debate over B-1A production reached a culminating point as the 1976 presidential election campaign ended. Although Congress was poised to act on the production decision, it delayed committing to all 244 B-1A aircraft until after the change in administration. Congress was concerned about escalating costs and increasing pressure from public opposition groups who led organized protests against nuclear weapons and the military-industrial complex. The B-1A program made for an easy target and became a cornerstone of presidential candidate Jimmy Carter's campaign.

President Carter had been in office for nearly six months before acting on his campaign promises about the B-1A. He charged his new secretary of defense, Harold Brown, to reexamine the need for the bomber and deferred any action until spring. Brown, a former secretary of the Air Force, used his position and expertise on the subject as he shouldered the responsibility of reporting to the president the recommended way forward for the B-1A production decision. Brown pointed out that the Air Force program was well structured to allow for the delay as the administration changed over, allowing the president to answer some fundamental questions about his defense posture. Brown tried to reconcile overall program cost with the importance of the bomber as a component of the nuclear triad and to US strategic capability.[54] Nonetheless, on 13 June 1977, President Carter decided to block funding for B-1A production. While citing excessively high costs for a single major weapon system, he called his choice "one of the most difficult decisions I've made."[55] His official statement explained his rationale as limited to four choices: build all 244 B-1A at a cost of $30 billion; cancel the B-1A and deploy long-range air

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[52] Donnini, *Battling For Bombers*, 65.
[53] Donnini, *Battling For Bombers*, 65.
[54] Donnini, *Battling For Bomber*, 65.
[55] Donnini, *Batling For Bomber*, 68, Kotz, *Wild Blue Yonder,* 171.

launched cruise missiles on the B-52; do nothing, let the B-52s wear out, and let the nuclear triad become a nuclear dyad; or move slower with the B-1A and monitor costs very closely during the system's development. Despite cancelling the program, Congress allocated an additional $2 billion to extend research and development for the bomber, leaving the program alive but on a respirator.[56]

B-1B

Just over four years later, newly elected President Ronald Reagan pledged his intent to build 100 modified versions of the B-1 to restore the strategic balance upset by the rising Soviet nuclear threat.[57] This announcement was just one of Reagan's announced five steps for a major US strategic modernization program estimated to cost $100 billion. He also announced plans to build 100 MX missiles; to improve TRIDENT II submarine-launched missiles; to upgrade the nuclear command and control system; and to build a follow up fleet of 132 stealth bombers to supplement the 100 B-1s.[58]

Reagan's decision on the B-1B made good on his campaign promise, and his pledge to produce 100 aircraft came very quickly after his inauguration in 1981. Such an early decision in the new presidency on the B-1B was possible because of the continuous development funding allotted by the Defense Department. Senior Air Force leaders anticipated an opportunity to build a new bomber with a change in administration and had prepared for the decision expected from the new president.[59]

Ultimately, Congress funded production of the 100 newly labeled B-1B aircraft, down from 244 in the original 1969 proposal. This reduction in total aircraft production, coupled with significant changes made in the B-1B model, increased the overall cost of the program. Air Force estimates stood at $20.5 billion or approximately $200 million for each airplane.[60] Also affecting the price increase was the excessive subcontracting used as a political strategy to gain widespread constituency support. The General Accounting Office and many members in Congress continued their now regular inquiries into cost and

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[56] Donnini, *Battling For Bombers*, 68.
[57] Donnini, *Battling For Bombers,* 78.
[58] Donnini, *Battling For Bombers,* 80.
[59] Donnini, *Battling For Bombers*, 78.
[60] Donnini, *Battling For Bombers,* 79.

to question the need for a new strategic bomber. On the other side, supporters of the aircraft went to great lengths to make their case for the bomber. In addition to White House support, senior Air Force and civilian leaders used the media to officially explain and promote the capabilities of the aircraft. Secretary of Defense Edward Aldridge flew the B-1B and stated to a defense subcommittee of the House Appropriations Committee that the critics of the B-1B were not encumbered by the facts and they were wrong. The Air Force launched a media campaign by ordering all base newspapers to print a series of "advertorials" aimed at defending and explaining the capabilities of the B-1B. The commander of the first operational B-1B squadron remarked how 1986 was "a year of high frustration … fielding the airplane and reading about how it wouldn't work." The SAC public relations director observed few positive but many negative stories about the B-1B.[61]

B-1B modifications added significant costs to the production aircraft, but added significant technological improvements over the less expensive B-1A. The numerous and practical changes made to the design improved capability in what the Air Force viewed as future B-1 missions, such as adding non-nuclear bomb modules to use the aircraft in a secondary conventional role. Although the nuclear mission was the primary Air Force vision for the aircraft, having conventional capabilities made it easier to claim the aircraft was a multi-role bomber which could replace the B-52.[62] Structurally the B-1B was 80 percent the same as the prototype B-1A, but the B-1B model had an additional 40 tons of structural weight to support more fuel, and more internal and external weapons carriage capacity. The B-1A's maximum gross weight was 395,000 pounds, while the B-1B's weight increased to over 477,000 pounds. Engineers added 8,000 pounds of structural weight to accommodate an increased weapons payload of 50,000 pounds and an additional fuel capacity of 24,000 pounds.

To improve penetration capability, designers added radar-signature-reducing vanes which made the radar cross section one-tenth that of the B-1A and one percent that of the B-52. The avionics were significantly better, despite

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[61] David C. Morrison, "Ink on the Bird," *National Journal*, 8 October 1988; Chuck Vinch, "Air Force Campaign Promotes B-1," *European Stars and Stripes*, 4 April 1987.
[62] Donnini, *Battling For Bombers,* 79.

continued problems with the defensive electronic jamming avionics system. Low-altitude speed was somewhat improved, from Mach 0.85 to 0.92. Design tradeoffs left the B-1B with the capability for speeds of about Mach 1.2 at altitude, a reduction from the B-1A's Mach 2 performance.

B-1B Design Problems

Due to the start-and-stop political process associated with B-1 development, the design of the electronic counter measures (ECM) systems, crucial to the effectiveness of the radar jamming capabilities on the aircraft, was not fully developed when the B-1A program was terminated. Once B-1B production began again in 1981, the original company, AIL Systems, was re-contracted to develop the B-1B ECM system. It was the most comprehensive ECM program ever initiated. The 1976 defection of Victor Belenko caused design requirements to change, adding more complex and effective jamming techniques to counter expected advances in Soviet fighter radar. The third B-1A prototype aircraft, designed as an avionics test bed, carried the initial electronic counter measures system, the AN/ALQ-161. Changing design requirements demanded technologies not yet engineered, so ECM system development suffered, and brought B-1B survivability into question.[63]

Rockwell invested $600 million to manufacture the B-1B. This investment provided state-of-the-art production machinery and tooling. Rockwell demonstrated effective productivity by completing 50 B-1B aircraft in 1987, cutting production-per-unit costs by reducing labor hours from 22,000 to 11,000 hours per aircraft – an estimated $1.0 billion cost reduction. Despite the long-term problems with the ECM system, Rockwell's North American Division earned the Manufacturing Productivity Award for its success in producing the B-1B. The award cited Rockwell for increased efficiency, building right the first time, effective management which finds and corrects problems, and the implementation of actions to reduce weapon system costs.

The Combined Test Force conducted B-1 flight testing at Edwards AFB. Flight tests involved airframe, avionics, and weapons integration. Because the avionics changes on the B model were much more significant than the

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[63] Congressional Budget Office, *Options for Enhancing the Bomber Force* (Washington DC: Congressional Budget Office, July 1995), 16.

structural changes, flight testing focused on the upgraded avionics system, including the terrain-following radar and added weapons capabilities. The avionics testing included basic software testing of the offensive and defensive systems. Weapons compatibility testing determined if existing Air Force weapons could be safely carried and launched from the B-1B. Compatibility testing was accomplished for three gravity nuclear bombs and three nuclear missiles.[64] The first live B-1 missile launch, of a Short Range Attack Missile (SRAM), took place on 16 January 1987 at the Tonopah test range in Nevada. Following the SRAM testing, flight tests certified the B-1 to carry the Air Launched Cruise Missile. A third nuclear missile, the Advanced Cruise Missile, took advantage of low observable (stealth) technology. Engineers tested this weapon on the B-52H and the B-1 concurrently. Although the Air Force certified the B-1 to carry and release this missile, it was not included on the inventory of approved weapons once the B-1B reached its Initial Operating Capability. The final stages of flight test evaluated six critical areas: navigation reliability and accuracy, low level penetration capability, survivability, weapons delivery, mission reliability, and diagnostic capability.[65]

Once flight testing and operational mission certification ended in 1986, the B-1B wasted no time showing itself off as the "most advanced bomber in the world."[66] It made its international debut at the Paris Air Show in June 1987. The following month, the 58th aircraft built took off with a payload of 66,140 pounds, equivalent to 24 SRAMs. It flew a 500-mile closed circuit course at 500 feet above the ground to set a world speed record with an average speed of 678.48 miles per hour over 620 miles, and set another world record over 1,240 miles with a speed of 669.52 miles per hour.[67] Other significant flights occurred in 1987, including a 21-hour flight along the Soviet northern tier above the 70 degrees north latitude line. Over the course of the next three years, the B-1B continued to set numerous world speed and time-to-climb records. The crews and the weapon system also earned 1st place and 3rd place

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[64] Logan, *SAC's Last Bomber,* 44.
[65] Logan, *SAC's last bomber*, 54.
[66] Pete Aldridge, Secretary of the Air Force, 1987. Quoted in Holder, *The B-1 Bomber,* 88.
[67] Logan, *SAC's Last Bomber*, 225-226.

at their first SAC bomb competition (Proud Shield) in 1988; they also earned the highest score ever recorded for a SAC operational readiness inspection (ORI) in 1990.[68] In 1991, the B-1B completed non-nuclear certification using 84 live 500 pound bombs from 500 feet above the ground at 650 miles per hour.

Despite the new bomber's outstanding operational performance, changes in the international security environment which had determined the B-1Bs roles and missions drove more political decisions affecting the weapon system. In September of 1991, President George H. W. Bush pulled all B-1Bs from nuclear alert and cancelled funding for the SRAM II missile development program as part of his unilateral strategic nuclear reductions. By June of 1992, SAC was deactivated and the B-1B, along with the remaining B-52s still in service, joined the new Air Combat Command.[69]

The B-1B found itself on the cutting edge of technological advancements in computers, radar-defeating stealthy components, and swept-wing technology. Components from the space shuttle program, such as the Computer Integrated Test System, found secondary utility onboard the B-1B. Its inertial navigation system (INS) was the most advanced ever built. The computer technology, navigation, and terrain-following radar innovations were crucial to the development of other follow-on programs such as the B-2. The swept-wing configuration provided high altitude super-sonic speed along with low-level maneuverability. Solid-state electronics throughout the aircraft advanced the capability options for programmers developing smarter self-protection ECM techniques well beyond the simple and inefficient barrage jamming found in existing systems. However, being on the cutting edge became both the crux and criticism of the B-1 program. Strategic requirements and Air Force expectations often exceeded design and engineering achievements.

Conclusion

The politics behind any weapon system are complex. In the case of the B-1, political factors, more than anything else, motivated both the critics and supporters of its development. Its design approval endured the trial of presidential elections and the political agendas of ideologues on both the left

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[68] Logan, *SAC's Last Bomber*, 226.
[69] Logan, *SAC's Last Bomber*, 226.

and the right, as well as the parochial political arguments of members of Congress. Another factor in its design approval was the drive to match the Air Force's conception of airpower and serve as the symbol of the service's vitality. Finally, the program had to fit within the strategic requirements designed to counter the Soviet Union during the height of the Cold War.[70] Almost three decades after the Air Force started seeking a new bomber, the B-1 finally emerged as one component of the nuclear deterrence force.

Advocates emphasized the B-1 design as a multi-role platform, with considerable conventional capability, not just a purely strategic nuclear weapon. The B-1 became operational before the Advanced Technology Bomber (ATB), later known as the B-2, and filled the gap between the increasingly vulnerable B-52s and the introduction of the ATB. President Reagan decided the best strategic and political solution available to the nation was to purchase both the B-1 and the ATB (B-2). The B-1B's reputation for being politically and strategically contentious plagued its credibility and masked its combat capability for many years, despite its having performed admirably during nuclear assurance and operational readiness inspections and having maintained a stellar record during SAC bomb and navigation competitions. Most supporters of the B-1B believed that a two-bomber approach, fielding B-1s first and introducing ATBs later, was best to improve the manned penetration portion of the nuclear triad, a critical component of national security and the Air Force during this period.

[70] Kotz, *Wild Blue Yonder*, 249.

Chapter 2

CONVENTIONAL TRANSFORMATION

It was a one-man fight in a fighter pilot's Air Force to get support for the B-1.

-- General Michael Loh, USAF, Commander ACC

Our aviators who know the airplane, sir, are willing to fly it, to take it to combat under the conditions we will set out for it, and we are willing to bring this bomber up to its national capability.

-- Maj General Larry L. Henry, USAF

In the wake of the Persian Gulf War, the Air Force envisioned a new type of dominant air warfare conceptualized around the idea of an overwhelming force of combat aircraft capable of delivering precision-guided weapons to the heart of an enemy or supporting the engagement and targeting enemy military forces during a regional conventional conflict.[1] In light of this vision for future warfare, General Michael Loh pushed the Air Force to develop a plan for augmenting capability in the conventional bomber force. The Air Force completed its plan for increasing bomber conventional capabilities, called the Bomber Roadmap, in 1992. The roadmap established conventional roles for each type of bomber, described the new types of accurate munitions those bombers required, and outlined the modifications and changes in training needed to improve each aircraft's ability to perform conventional missions.[2] The roadmap also outlined schedules and costs for developing weapons and modifying airframes. The service wanted to make sure its long-range bombers could provide the critical capabilities its senior leaders considered crucial during the early stages of a regional conflict.[3] Long-range bombers had to

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[1]Congressional Budget Office, *Options For Enhancing The Bomber Force,* (Washington DC: Congressional Budget Office, July 1995), 19.

[2] Congressional Budget Office, *Options For Enhancing The Bomber Force*, 20.

[3] Dr Sheila E. Widnall, Secretary of the Air Force, "The State Of The Air Force," *Report of the Secretary of the Air Force to the President and the Congress,* (Washington, D.C.: Government Printing Office, February 1995). "While the B-2 is the head of the fleet, the B-1 is the backbone with its greater numbers, larger payload, and higher speed. The B-1 recently demonstrated its capability to sustain wartime operating rates in an operational readiness assessment, greatly surpassing the required mission-capable

deliver conventional capabilities from bases in the United States, using a wide variety of weapons during the early stages of any major regional conflict to give tactical reinforcements from the United States or coalition countries time to arrive in the theater.[4] A major part of the recommendation involved modifying the B-1 weapon system for conventional warfare—a difficult task considering that B-1 design and operational testing focused primarily on the nuclear mission.[5]

This chapter details the peacetime innovation in the B-1 weapon system.[6] It shows how the B-1 aircraft and its organizational squadrons changed to meet the demands of the shifting strategic and technological environment. Rosen argues that peacetime military innovation occurs when senior military officers formulate a strategy for innovation which has both intellectual and organizational elements. As General Loh accepted the B-1 into the newly formed Air Combat Command, he led the drive toward two major innovations, modifying the aircraft for conventional warfare and transforming B-1 units and aircrew into legitimate and capable elements of the Air Force conventional combat arm. He accomplished this by directing the initiation of major technological upgrades on the aircraft, and by integrating the weapon system into the combat training elements of ACC such as the Air Force Weapons School and Red Flag exercises. As the B-1 transitioned from Strategic Air Command into Air Combat Command, a shift in organizational culture occurred. The changes in mission, organization, training, and weapon system technology provided a window for innovation, and the opportunity for the B-1 community to develop attributes of a learning organization as it assumed the role described by Air Force senior leaders as the backbone of the conventional bomber force. The period of peacetime innovation ended with the weapon system's first combat successes in Operations Desert Fox and Allied Force—crowning events in the B-1 conventional transformation.

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rate. The B-52H provides an economical means to conduct standoff precision attacks or direct attacks."

[4] GAO Report to the Chairman, Committee on Armed Services, U.S. Senate. *Strategic Bomber: Issues Relating to the B-1B's Availability and Ability to Perform Conventional Missions*, January 1994, 19.

[5] Congressional Budget Office, *Options For Enhancing The Bomber Force*, 12.

[6] The B-1B weapons system is referred to simply as the B-1 for the rest of this thesis.

In the early 1990s, the B-1 force was ill equipped to conduct the early missions of a Major Regional Conflict (MRC).[7] Surprisingly, the B-1 and B-2 conventional capability was limited to delivering unguided gravity bombs. From the beginning of the Cold War until the end of the Persian Gulf War, bombers were regarded primarily as nuclear assets, and their avionics and weapon systems were designed for those nuclear missions.[8] Nuclear operations demanded that the bombers fly away from their home bases within minutes of first warning to escape an incoming nuclear barrage and then, because communications would be limited, execute their missions in limited contact with the outside world. Because they would be attacking fixed targets, all of the details of the mission, including target locations and flight paths, were pre-recorded onto magnetic tapes and loaded into the aircraft's computers before takeoff. Consequently, the bombers did not train to and were not prepared for in-flight re-targeting or flight planning. The radar, targeting, and mission-planning systems on the bombers in the early 1990s reflected the design requirements of nuclear mission profiles.[9] After the Bomber Roadmap altered mission expectations, such rigid mission planning limited these bombers from performing some important tasks expected of them in conventional conflicts.

Although the design and actual operational certifications for the B-1 included conventional capability, the Air Force could not realistically expect the aircraft, in the early 1990s, to perform future conventional roles. This deficiency in the B-1 also resulted from earlier priorities, when the Air Force struggled to rationalize investing in conventional capabilities while critics argued that other aircraft could perform the role more cheaply. Throughout the Cold War, the Air Force had emphasized its nuclear responsibilities during budget negotiations, and relegated conventional capabilities to a lower priority.

After the Air Force declared the B-1 weapon system operational in September 1986, the service focused on correcting unexpected design problems

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[7] General Loh used the MRC concept to argue that he did not have enough conventional bomber capability during the early 1990s. He used the 1994 bottom up review to derive his recommendation for how many bombers were needed to support the MRC strategy. General J. Michael Loh, USAF (Ret), interview by the author, 7 April 2010.
[8] Congressional Budget Office, *Options for Enhancing the Bomber Force*, 2.
[9] Congressional Budget Office, *Options for Enhancing the Bomber Force*, 18.

and integrating the weapon system into SAC's nuclear force. Since the Single Integrated Operational Plan (SIOP) specifically allocated the B-1 to a nuclear deterrence role until late 1991, the service did not expand its conventional capability beyond its initial certification, which was a limited capability to deliver non-precision 500-pound gravity bombs.[10] The training regimen in the B-1 squadrons virtually ignored any conventional training or capability. Only aircrew members who had transitioned from the B-52 weapon system into the B-1 community through special selection boards, held to bring the most qualified aviators into the new bomber program, had any significant conventional weapons employment experience.[11] If the B-1 community was going to meet the new conventional role requirements set by senior leaders, it would have to change the aircraft's technological capability as well as aircrew and organizational training and tactics.

The commander of operations for the B-1 wing at Ellsworth AFB described preparations for conventional warfare as minimal, as the command had only begun to prepare the bomber for conventional roles in 1991 and its conventional capabilities were "just beginning to emerge." The weapon system did not, and in fact could not, participate in the few opportunities to perform conventional missions such as Operation Desert Storm. Historians offer several reasons to explain the B-1's absence from Desert Storm. Concerns over the aircraft's structural integrity were one of the primary reasons; routine inspections revealed a crack in the horizontal tail wing spar that led to the aircraft's untimely stand down in 1990. Members of at least one B-1 bomb wing preparing to deploy for Operation Desert Storm were surprised to receive the stand down order, rather than deployment orders, so that the Air Force

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[10] Colonel Eldon "Woodman" Woodie and Brigadier General Stephen "Seve" Wilson were the first two aviators to transition into the B-1 immediately after serving their first assignments as instructor pilots at the undergraduate pilot training bases. Colonel (ret) Woodie watched the B-1 transformation evolve from its nascent stages during nuclear alert missions until late 2007 when he retired as the Minot Air Force Base Wing Commander. Brig Gen Wilson also experienced the B-1 transformation and serves currently as the 379 AEW/CC, responsible for B-1 operations in OEF and OIF. Interviews by the author in Feb and Mar 2010.

[11] Col (Ret) Eldon Woodie, 9 BS/CC 1999-2002, interview by the author, 13 February 2010.

could fix the wing crack across the entire fleet.[12] Perhaps the most glaring reason to the aircrew and Air Force leaders at the time was that B-1 squadrons had not trained extensively for conventional operations, nor for expeditionary deployments.[13] Most B-1 units were only trained and proficient at their nuclear mission because of the SIOP's national priority and their alert commitments. Only six crews were certified to drop conventional weapons in the B-1 at Ellsworth AFB at the time. Each of these factors, in combination, contributed to keeping the B-1 from participating in Operation Desert Storm; in short, the weapon system was just not yet prepared for conventional warfare.

The Air Force's Bomber Roadmap laid out a plan for modernizing the bomber force, developing new munitions, and integrating them with each of the aircraft. The Air Force envisioned an active force structure of 181 bombers by 2001: 20 B-2s, 95 B-1Bs, and 66 B-52Hs. Approximately 154 of those, including 16 B-2s, 82 B-1Bs, and 56 B-52Hs, would be funded to fly—known as primary authorized aircraft (PAA).[14] The service fielded a smaller force, however, in the years leading up to 2001. The Air Force only funded 60 B-1s to fly out of the 95-total aircraft inventory. The service placed the remaining 35 aircraft on reconstitution reserve status; they were flown but not funded. This measure allowed the Air Force to save money in the short term while the bombers were still being modified for conventional missions and while it developed the new generation of accurate munitions.[15] In another effort to reduce costs, the Air Force also transferred two squadrons of B-1s, 18 aircraft, to the Air National Guard.

The B-1 represented an important element of the Bomber Roadmap, yet this plan was criticized for relying on precision guided munitions that had not been developed. The Air Force did not expect to field these capabilities until

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[12] Col (Ret) Eldon Woodie, 9 BS/CC 1999-2002, interview by the author, 13 February 2010.
[13] Col Woodie, interview by the author, 13 February 2010.
[14] Operational inventory refers to aircraft that are funded to fly. Total inventory represents total aircraft. The Air Force uses the term "reconstitution reserve" to describe the concept of funding enough flying hours and flight crews for a smaller number of aircraft than what is in the total inventory. The actual total number of aircraft in the inventory are all flown, however, each of them are flown only enough to represent the same as the funded amount of aircraft. Congressional Budget Office, *Options for Enhancing the Bomber Force*, 20.
[15] Congressional Budget Office, *Options for Enhancing the Bomber Force*, 20.

after the year 2000. The Air Force program office and industry would have to develop and purchase support systems and modify the B-1 significantly so that it could carry the proposed precision guided munitions still under development. Likewise, the B-1's capacity to deliver those weapons over modern air-defense threats relied on the successful incorporation of a modified defensive avionics system, which was also not yet operational.

Air Force Chief of Staff General Merrill A. McPeak convened a bomber summit in early 1993 to evaluate the status of the program before committing to the B-1's conventional transformation. McPeak wanted to address B-1 lethality, survivability, and supportability concerns, three areas he considered crucial for the modification.[16] The bomber summit provided General Loh the opportunity to gain McPeak's support for the recommended B-1 conventional transformation, so Loh stressed the importance of the new B-1 filling the capability gap left by retiring the B-52Gs.[17] McPeak approved the conventional capability enhancements recommended by Loh in his B-1 conventional concept of operations briefing during the B-1 bomber summit. He agreed with Loh that expanding the B-1 mission was the best way to exploit the aircraft's inherent war-fighting strengths. McPeak then charged his supporting commands to improve the lethality, supportability, and survivability of the B-1 in its emergent conventional role.[18] This focus led to the approval of the Conventional Mission Upgrade Program, which set in motion the drive to make the aircraft a conventional workhorse soon to be touted by Air Combat Command as the backbone of the conventional bomber force. A flurry of activity seemed to be emerging once again around the policies, funding, and relevancy of the B-1 bomber. A new way of warfare began to emerge for the B-1 weapon system.

Conventional Makeover

The B-1 Conventional Mission Upgrade Program (CMUP) was a multi-project effort to upgrade the weapon delivery and defensive systems on the

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[16] CSAF Archives, 5 April 1993. IRIS Call number K168.03-1440. June 1993.
[17] General John M. Loh, USAF (Ret), interview by the author, 7 April 2010.
[18] CSAF Archives, 5 April 1993, AFHRA K168.03-1440, June 1993. McPeak wrote three hand written directives specifying the Lethality, Survivability, and supportability priorities for each of the supporting commands or Air Staff agencies responsible for B-1 programs.

aircraft for successful operations in a conventional theater war.[19] The CMUP design requirements, which were finalized in late 1994, focused on ensuring the B-1 could deliver precision weapons against heavily defended targets deep into enemy territory during both conventional and nuclear operations.[20] The $2.7 billion CMUP program laid the groundwork for a complete makeover of the B-1 mission, transforming it from a low-level nuclear penetrator to a modern multi-role conventional or nuclear bomber. The Air Force identified specific requirements focused on improving lethality, survivability, and sustainability for the new conventional mission.[21] The various upgrade phases of CMUP began in 1993 and continued through 2004.[22]

The B-1 CMUP employment parameters evolved from the Concept of Operations (CONOPS) envisioned by Air Combat Command, which defined B-1 roles and missions in congruence with the 1992 Bomber Roadmap. The CMUP improvements focused primarily on strategic-offense, interdiction, offensive-counter-air, and mine warfare missions to support conventional operations.[23] CMUP final operational requirements relied on the detailed Rationale Report (RAMS), issued by ACC in November 1993, which documented the rationales and tradeoffs made throughout the requirements development and acquisitions process. ACC used an analytical, structured, and iterative process stressing reliability, availability, maintainability, and supportability (RAMS) factors to

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[19] Final Operational Requirements Document, *CAF 357-92 (SAC 007-92) I/II-A, for B-1 Conventional Upgrade Program,* Revision 1," Signed by: John M. Loh, General, USAF, Commander, Air Combat Command, ACC, 19 December 1994. SECRET/NOFORN/WNINTEL Document retains classification, Excerpt unclassified IAW EO12958, 29 Jan 2010.

[20] Final: Operational Requirements Document, for *B-1* Conventional Upgrade Program, Revision 1. Signed by: General John M. Loh, General, USAF, Commander, Air Combat Command, ACC/CC. 19 December 1994. (Secret/NOFORN/WNINTEL) Document Retains Classification Excerpt Unclassified IAW EO12958 on 29 Jan 2010. See also: B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. Iris Record: AFHRA K150.01 V.6 Supporting Document II-35.

[21] Final: Operational Requirements Document ORD *B-1 Conventional Upgrade Program,* Revision 1." 19 Dec 1994, SD B-232. ACC History 1994.

[22] History of Air Combat Command. 1 January – 31 December 1994. Volume 1: Narrative. AFHRA K 401.01 v.1 Classification: Secret. Document Retains Classification, Excerpt Unclassified IAW EO 12958. 29 Jan 2010.

[23] Final: Operational Requirements Document, for *B-1* Conventional Upgrade Program, Revision 1. Signed by General John M. Loh, ACC/CC. 19 December 1994.

generate the report.[24] The primary RAMS driver was for a weapon system to meet the reliability parameters for Mission Completion Success Probability (MCSP), spelled out in the CONOPS vision for B-1 combat missions and roles. The RAMS process developed assessment measures and analyzed each area to meet the development criteria.

The CMUP modified B-1 capabilities in terms of lethality and survivability by replacing or augmenting existing B-1 systems with non-developmental items. Lethality modifications expanded the conventional mission capability through munitions and communications improvements. Survivability modifications upgraded the defensive system.[25] The program was accomplished in three phases, eventually leading to four major upgrades on the aircraft, known as block upgrades, Block B, Block C, Block D, and Block E; there were also two follow-on weapon upgrades, known as sustainment blocks SB-10 and SB-12 upgrades.[26] CMUP implementation provided six new capabilities for the B-1, all of which were considered mission critical functions to meet the two wartime mission profiles. The first mission profile was a CONUS-to-CONUS mission during the initial phase of operations, lasting up to 35 hours in length while being flown from home station. The next mission profile was a forward deployed mission, during sustained operations, which could last up to 12 hours in length and was flown from an unknown forward deployed location. The six new capabilities enabled the B-1 weapon system to meet its anticipated conventional wartime tasking.

Five of the new capabilities improved B-1 weapon system lethality. The first integrated precision satellite guided weapons. The Joint Direct Attack Munition (JDAM) took center stage in the initial CMUP requirements order.

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[24] B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. AFHRA K150.01 V.6 Supporting Document II-35.

[25] Final: Operational Requirements Document, " for *B-1* Conventional Upgrade Program, Revision 1.". Signed by General John M. Loh, ACC/CC. 19 December 1994.

[26] The initial RAMS document, CONOPS, and CMUP documents did not reference the Block or Sustainment Block designations until later in development. Also, Block F, the Defensive Systems Upgrade was only partially completed; the ALE-50 Towed Decoy system and some ALQ-161 modifications were made. However, the full Block F modification was never considered installed on the aircraft and was cancelled in December 2002 due to escalating schedule and cost growth and a lack of maturity on the program technology.

JDAM would be carried on the 8-weapon multipurpose rotary launcher (MPRL). JDAM integration consisted of Interface Control Document development, software, stores separation testing, and other flight testing measures.[27]

Incorporating a MIL-STD-1760 interface, along with JDAM integration, would boost the weapon system's lethality. CMUP installed full MIL-STD-1760 capability in all weapons bays, which included new weapon interface units (WIU), power control assemblies (PCA), and cabling. The new WIUs would receive launch commands via a 1553 data bus, fired squib commands to the ejectors, and monitored weapon presence or away status. Software modifications included codes to rotate the launcher, pass targeting information to the weapon, and control the displays for weapon status on the aircrew controls and display monitors. [28]

A third tier of the CMUP focus to improve weapon system lethality was adding the Global Positioning Satellite (GPS) capability to the B-1. This improvement was twofold, it was integrated into the aircraft navigation system and displayed position accuracy on the pilot and Weapon Systems Operators' (WSO) avionics displays. It also enabled the GPS handoff of accurate time and position to satellite guided weapons during targeting and launch procedures. Although CMUP evaluated several approaches to GPS integration, the program office decided to integrate a miniature airborne GPS receiver, with available antenna, electronics, controls and displays- all non-developmental items.[29]

The fourth and fifth mission critical upgrades would be the communications and computer modifications. The B-1 communication system plan would upgrade the aircraft with jam-resistant voice communications, including Have Quick II and Single Channel Ground-Air Radio System (SINCGARS) capabilities, which were interoperable with forces operating in the UHF and VHF bands. The upgrades also provided UHF voice SATCOM capability. The program office chose the ARC-210 multi-band R/T unit

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[27] B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. AFHRA K150.01 V.6 Supporting Document II-35. 14.
[28] B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. AFHRA K150.01 V.6 Supporting Document II-35. 15.
[29] B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. 15.

consisting of a radio control unit, two tunable antennas, and two radio group kits, one for the voice SATCOM and one for normal line-of-sight radio usage. The computer upgrade would replace four avionics control units and a Mass Storage Unit, with new, substantially more capable computers. At the time of the original CMUP requirements design, the computer choices were not made nor developed; it was not until phase II of the CMUP program that the computer hardware and software replacement decisions were made.

The sixth mission-critical upgrade centered on aircraft survivability. Survivability was always a pivotal design requirement for the B-1 and it remained so throughout the conventional transformation. The Air Force believed the conventional mission required "more robust radar-warning and countermeasures capability than the nuclear mission."[30] In order to prepare the B-1 for current and future threats, the Air Force planned to dedicate nearly $1 billion of the $2.5 billion conventional conversion program toward defensive avionics. The Defensive System Upgrade (DSUP) considered approximately seven potential solutions in 1993.[31] The solutions evaluated ranged from retaining most of the existing ALQ-161 system, to adding new Line Replaceable Units (LRUs), to replacing or modifying the entire system. Each of the seven systems proposed consisted of “off-the-shelf” electronic warfare systems requiring little or no modification.

General McPeak’s directive to improve B-1 lethality also spawned several initiatives addressing weapon suspension, release, and jettison issues that had been reported as major problem areas for the conventional use of the B-1. The Joint Standoff Weapon (JSOW), naval mines, and the Tri-Service Standoff Attack Missile (TSSAM), later known as the Joint Air-to-Surface Standoff Missile (JASSM) would also be integrated onto the B-1 as part of the CMUP. The block modifications also included improvements to the Conventional Bomb Module and multi-purpose rotary launcher.

The plan integrated existing weapons such as cluster bombs and anti-ship mines onto the aircraft first, and then integrated weapons still in

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[30] Congressional Budget Office, *Options for Enhancing the Bomber Force*, 20.
[31] B-1B Conventional Mission Upgrade Program: RAMS (reliability, availability, maintainability, & supportability), Rationale Report, 8 November 1993. AFHRA K150.01 V.6 Supporting Document II-35. 16.

development, such as the JDAM and JSOW, once these new weapons were in production.[32] Integrating conventional CBU-87, CBU-89, and CBU-97 munitions were projected to cost approximately $60.9 million.[33] The Air Force anticipated that it would cost approximately $332.5 million to integrate the Joint Direct Attack Munition (JDAM) and MIL-STD-1760 data bus. The final phase of the weapons upgrade was calculated to cost approximately $196 million to add the JSOW and JASSM weapons to the B-1 arsenal. The secure radio and electronic defensive system modifications were expected to be completed in early 1999

By late 1994, General Loh had finalized and signed the final Operational Requirements Document (ORD) for the CMUP, however, there were still a lot of hurdles to overcome before the program was underway.[34] During this time, the Institute for Defense Analysis was gathering model data for the final phase of an on-going Cost and Operational Effectiveness Analysis (COEA) for the B-1 program. The COEA was supporting a Defense Acquisitions Board decision regarding the electronic countermeasures (ECM) system. However, the Congressional Appropriations Committee eliminated the ECM upgrade research and development funds for 1994, delaying the ECM portion of the CMUP. Headquarters Air Combat Command approved scaling back ECM upgrades by not completing a full analysis of two to four final options. The ECM upgrade assessment still had to show that it met survivability requirements set forth in the 1993 Program Decision Memorandum signed by the Under Secretary for Defense for Acquisitions.[35] The B-1 Program Decision Memorandum stipulated that the Strategic Systems Committee must review the CMUP program prior to entering the development phase of JDAM weapons integration.[36] The tasks to be completed before the Strategic Systems Committee review were: identifying

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[32] ACC History 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan - 31 Dec 1994. 223.
[33] ACC History 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan - 31 Dec 1994. 224.
[34] Final: Operational Requirements Document, "*B-1 Conventional Upgrade Program,* Revision 1" 1994.
[35] ACC History 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan - 31 Dec 1994. 226.
[36] ACC History 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan - 31 Dec 1994. 227.

ECM system requirements, performing vulnerability analysis, and updating the Test and Evaluation Master Plan. Once these tasks were completed, securing the approval of the Office of the Secretary of Defense for the CMUP acquisition baseline was the final hurdle toward the B-1 conventional transformation vision, according to General Loh.[37]

One of the biggest challenges facing Air Combat Command in its CMUP effort came from continuous military budget reductions. Just as the CMUP was being finalized, the 1994 and 1995 presidential budgets slashed nearly $500 million from the B-1 programs.[38] These cuts affected ECM upgrades as well as a separate funding line used to support ongoing improvements to the operational B-1 software. According to ACC these cuts were a congressional error, essentially resulting from bureaucratic accounting mistakes. The congressional budget reportedly confused ongoing operational and maintenance cost increases with the CMUP implementation, leading to a cut in funding to existing operational maintenance and sustainment funding. The cut therefore affected the ongoing upgrades required to ensure the operational readiness of the aircraft. This forced Air Combat Command to divert funding from the CMUP toward operations and maintenance software support once the discrepancy was discovered.[39]

At nearly the same time the B-1 was approved for conventional modification, the Department of Defense was reacting to indicators that appropriations bills for 1994 would see drastic reductions. In a 3 June 1993 letter to the service secretaries, Secretary of Defense Les Aspin charged each service to identify ways to implement program reductions if the proposed budget cuts occurred.[40] Although the extent of cutbacks was unknown, estimates were as high as $5 to $6 billion. Because of the programmatic consequences of such severe budget action, the secretary asked for formal coordination of any proposed terminations, project cancellations, or reduction

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[37] General J. Michael Loh, interview by the author, 7 April 2010.
[38] History of Air Combat Command, 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan -31 Dec 1994. 228-230.
[39] History of Air Combat Command, 1994, Joseph Ralston, General, Commander ACC. K401.01 v.1. 1 Jan -31 Dec 1994. 228.
[40] Les Aspin, U.S. Secretary of Defense. Memorandum for Acting Service Secretaries From Office of Secretary of Defense. 3 June 1993. IRIS Records, 3 Jun 1993, CSAF Files. K168.03-1440.

of any acquisition programs. Aspin requested services adhere to the priorities already set in place, while acknowledging the services might not be able to meet those priorities at the lower budget levels. He believed the challenge for the services was to provide information to Congress concerning how the reduced budget would impact national defense. The potential cuts could mean disaster for defense readiness and planning, thus the defense secretary made every effort to detail and justify the top and urgent funding priorities for the entire Department of Defense.

Congressional Oversight

General Loh, as the Air Combat Command commander, commonly fielded policy questions on the use of bombers. What role, if any, could the B-1B perform if war broke out next week, next year, or in the next 5 years?[41] In 1993 and 1994, Loh's answers were that the B-1 could only provide the 500-pound conventional gravity munitions, but that a capability for cluster munitions could be added within two years.[42] Furthermore, congressional oversight committees scrutinized all B-1 funding because of the already extremely high cost of development for the new bomber and because of the perceived design and operational problems with the new aircraft.

In fact, Congress criticized the Air Force for not correcting or addressing B-1 deficiencies earlier. Many of the CMUP focus areas addressed improvements toward lethality, survivability, and sustainment that Congress had already addressed in 1988 as the aircraft reached its initial operating capability.[43] On 4 May 1994, during hearings before the legislation and national security subcommittee of the Committee on Government Operations, congressional leaders directly criticized the Air Force's efforts to address the deficiencies in the bomber program.[44] Congress was reluctant to fund the

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[41] General (Ret) John Michael Loh, interview by the author, 7 April 2010.
[42] Congressional Budget Office. "Options for Enhancing the Bomber Force. CBO Papers, Washington DC. July 1995. 20.
[43] Congressional Budget Office, "*The B---1B Bomber and Options for Enhancements."* A special study completed in August 1988.
[44] U.S. Government Printing Office. Hearing held on 4 May 1994. Statement of Hon. John Conyers, Jr. Representative in Congress from the State of Michigan, and Chairman, Legislation and National Security Sub-Committee. Committee On Government Operations.. 82-427 CC Washington: 1994.

conventional upgrade for an underperforming weapon system that was originally supposed to be both a nuclear penetrator and a conventional bomber.

Congressman John Conyers referred to a 1991 report which pointed out the B-1 was originally intended to serve as both a nuclear penetrator and a conventional bomber, yet its capability to perform either role was highly questionable. He claimed that the program was still not on track despite being granted three years from the original bomber roadmap given to Congress in 1992. The committee further questioned the Air Force's request for an additional $2.9 billion investment in the B-1 program to complete the conventional capabilities modifications proposed in 1993.[45] Chief among the committee's criticisms was readiness, mainly the "dismal mission capable rates, inadequate radar-jamming systems, engine problems, and manufacturing defects."[46]

The committee specifically addressed six complaints: readiness, ineffective defensive avionics, ineffective inlet/engine anti-ice system, engine problems, incompetence at releasing accurate conventional weapons, and emerging structural cracks in the horizontal stabilizer. Conyers complained that the "American people have spent approximately $30 billion on the B-1 program … Yet the fact remains that the plane still cannot fully perform the job it was designed to do." He then welcomed Congressman Al McCandless to discuss the proposed modifications by the Air Force.[47] McCandless said:

> Today our subcommittee revisits the B-1B bomber and asks whether proposed improvements, estimated to cost between $2.5 and $3 billion, are a wise investment. Without question, the B-1B has suffered from highly publicized problems in the past. Yet, as most news these days, it is generally bad news that gets the most attention. I encourage all of our

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[45] U.S. Government Printing Office. Hearing held on 4 May 1994 Statement of Hon. John Conyers, Jr. Representative in Congress from the State of Michigan, and Chairman, Legislation and National Security Sub-Committee. Committee On Government Operations. 82-427 CC Washington: 1994.

[46] Opening Remarks by Congressman Conyers. U.S. Government Printing Office. Hearing held on 4 May 1994 Statement of Hon. John Conyers, Jr. Representative in Congress from the State of Michigan, and Chairman, Legislation and National Security Sub-Committee. Committee On Government Operations. 82-427 CC Washington: 1994.

[47] Opening Remarks by California's Congressman McCandless. U.S. Government Printing Office. Hearing held on 4 May1994May4, 1994. Statement of Hon. John Conyers, Jr. Representative in Congress from the State of Michigan, and Chairman, Legislation and National Security Sub-Committee. Committee On Government Operations. 82-427 CC Washington: 1994.

> members to approach today's hearing with an open mind, to listen to both the good and bad news regarding the B-1B. My hunch is that after hearing nothing but negative reports about the B-1B, many will be astonished with the B-1B's current capabilities and dramatic improvement since our last hearing in March 1991. To illustrate my point, the B-1B has received the best operational readiness inspection scores of any strategic system ever fielded. It has the best safety record in the first 6 years of any comparable bomber or fighter. It holds 47 world range, altitude, payload, and time to climb records. It has won every SAC bombing competition it has entered. The 125,000 pounds of payload is more than double the payload of either the B-52 or the B-2 and can fly at MACH .85 at 200 feet above the ground and 1.2 MACH at 35,000 feet.[48]

McCandless concluded by recognizing that the serious troubles certainly warranted continued oversight and scrutiny, but warned that past problems should not distort the views of the present, nor obfuscate plans for the future.[49] He then surmised that if the changes to the B-1 were not the best solution, the alternatives were to rely on the B-52, a nearly 40-year-old plane that was slower, carried much less payload, and was even more vulnerable to enemy radar. Alternatively, they could buy more B-2s at a cost between $600 million and $2 billion per plane—neither option made any more sense than the planned B-1 modifications.

The Air Force was challenged to keep the CMUP program going while Congress debated each year's defense budget cuts. Much of the congressional dispute centered on funding sources, methods, and reporting requirements, and Congress eventually blocked funds for any ECM upgrades using 1994 appropriations.[50] The reductions delayed the program's development, acquisition, and ultimately its projected limited operational capacity until February 2003 and full operational capability until around 2007. Expected costs for getting the ECM portion of CMUP back on schedule were $400 million in 1995 funding calculations.[51] Unfortunately, after Congress restricted the B-1's funding in 1994, the Office of Secretary of Defense further eliminated the ECM funding from the 1995 budget. Defense spending budget cuts for 1996

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[48] General Accounting Office Air Force Bombers: Conventional Capabilities of the B-1B Bomber (Testimony, GAO/T-NSIAD-94-169, 4 April 1994.
[49] General Accounting Office Air Force Bombers: Conventional Capabilities of the B-1B Bomber (Testimony, GAO/T-NSIAD-94-169, 4 April 1994.
[50] ACC history 1994. 232. K401.01.v1 1 Jan Dec 1994, 231.
[51] ACC history 1994. 232. K401.01.v1 1 Jan Dec 1994, 232.

totaled $500 million, leading ACC to question whether it would receive any further B-1 appropriations until 1997.[52] To compensate for the budget cuts and ECM delays, ACC broke CMUP into two segments, offensive and defensive, and focused first on the offensive precision guided munitions phases while calling for only measured improvements in the defensive ECM system.

Air Combat Command found an interim solution to ECM development delays by accepting a proposal from the subsystem's original design contractor, AIL Systems, Inc. Allowing AIL to implement an 80 percent sole-source solution enabled engineers to quickly add hardware previously tested to the existing ECM system, improving its situational awareness and jamming capability. The benefits of the proposal included enhanced survivability, earlier fielding of JDAM separate from the ECM modifications, and a lowered short-term cost of CMUP.[53] Although the interim solution provided a quick economical approach, it eliminated any of AIL's competitors from bidding, which could have spurred new ideas and solutions to the troubled ECM suite and systems. This single source solution limited DSUP options and caused development problems in the future when ACC reconsidered its funding priorities, including DSUP's funding.

Congress, still concerned with the low mission capable rate and skeptical of the Air Force's expensive modernization plan, demanded that the Air Force conduct an Operational Readiness Assessment (ORA), to determine whether one B-1 wing was capable of achieving and maintaining its planned 75 percent operational readiness rate for six months.[54] The wing would be given the full complement of spare parts, maintenance equipment, manpower, and logistic support equipment. If the system could not meet this readiness rate, Congress expected the analysis would help assess the system's supportability and identify the factors limiting it. Congress and the Air Force could then address

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[52] ACC history 1994. 232. K401.01.v1 1 Jan Dec 1994, 232.
[53] ACC history 1994. 232. K401.01.v1 1 Jan Dec 1994, 232.
[54] United States General Accounting Office. National Security and International Affairs Division. July 18, 1995. Section 132 of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) required the Air Force to test the operational readiness rate of one B-1 bomber wing, if the wing was provided the planned complement of spare parts, maintenance equipment and manpower, and logistics support equipment. The test—referred to as the B-1 Operational Readiness Assessment (ORA)—was conducted from June 1, 1994, through November 30, 1994. The Air Force issued its report, "B-1 Operational Readiness Assessment Final Report," to the congressional defense committees on February 28, 1995.

these factors in a cost-effective manner. The B-1 organization was optimistic that the ORA would prove the aircraft could achieve its operational readiness rate when given the full complement of support it had been lacking since becoming operational. Air Combat Command, with the assistance of the Air Force Operational Test and Evaluation Center (AFOTEC), developed the test plan. AFOTEC formed a test team that was the Air Force focal point for monitoring and reporting test activities. The unit selected for the ORA was the 28th Bomb Wing, Ellsworth Air Force Base, South Dakota. As required by the legislation, a two-week segment of the ORA consisted of a remote deployment. The Air Force selected Roswell, New Mexico, as the remote deployment site.

The Air Force conducted the ORA as Congress directed, and the Government Accounting Office (GAO) reported that the B--1 achieved its operational readiness rate.[55] The Air Force proved what its maintainers and operators had claimed, that the weapon system could achieve and sustain its 75 percent mission capable rate given a full complement of spare parts, equipment, and manpower. The GAO, however, criticized the assessment for not examining the cost of sustaining the entire B-1 fleet for long term operations. "The Air Force believes that the completion of ongoing initiatives in progress and the continued funding for spare parts and repairs will increase the fleet mission capable rate to 72 percent," the GAO report stated. The GAO's report to Congress, although validating the B-1 weapon system's supportability and operational readiness, questioned the Air Force's long-term sustainment plan and funding, which further jeopardized congressional support for CMUP.

Despite criticism from some in Congress and the media, the ORA confirmed what the grassroots mechanics, aircrew, and military tacticians knew from their hands-on experience with the B-1's capabilities. General Loh's belief in the B-1, along with the growing credibility and support generated from the aircrews associated with the aircraft, provided a strong foundation within ACC that encouraged the Air Force's continued support for the bomber's conventional mission upgrade. After nearly ten years of weapon system maturation, the B-1's image was changing its image. It no longer claimed the

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[55] The Air Force issued its report, "B-1 Operational Readiness Assessment Final Report," to the congressional defense committees on February 28 February 1995, 5.

iconic status of being the Air Force's newest weapon system, as when the commander of SAC declared that it was the "best bomber in the world today." Instead, it was now touted as the workhorse for the conventional mission, as seen by the 1995 statement that the aircraft was the 'backbone' of the bomber fleet.[56]

Once CMUP was funded and approved, it quickly infused the B-1 with new capabilities and sparked the engine of change in the community. The fleet received the first block upgrade by late 1995, less than a year after the final operational requirements document was approved. Block B avionics and munitions enhancements improved the aircraft's offensive avionics and enhanced the synthetic aperture radar, which performed precision mapping for targeting and navigation. The first block upgrade also improved the defensive countermeasures system to reduce the false alarm rates from electronic signals operating in the same range as many of the surface-to-air missile threats of the time. The second block upgrade occurred quickly as well.

Block C upgrade development began in 1995 and was finished in September 1996. Block C added the capability to deliver up to 30 cluster bombs simultaneously. The modifications applied to a total to 50 refitted bomb modules—enough to equip half the B-1 fleet. This capability gave the B-1 a distinct capability for battlefield interdiction, although it seemed to be a mission quickly fading away with the end of the Cold War and with the increased disdain for cluster munitions. The conventional mission transformation in the B-1 was far from complete, for the weapon system to be effective in future conflicts, such as the conventional air campaigns in the Balkans, Iraq, or Afghanistan, it needed a precision or near-precision weapon capability.

Conventional Force Integration

The intellectual element of General Loh's strategy for innovation focused on realistic conventional training and force integration. General Loh recognized that the B-1's conventional transformation was not simply organizational and technological. He understood the importance of preparing the aircrew and B-1 units for conventional weapons employment and force integration. He also

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[56] Dr. Sheila E. Widnall, Secretary of the Air Force, "The State of the Air Force." *Airpower Journal* – Spring 1995. Accessed online at: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj95/spr95_files/widnall.htm.

understood the importance of exposing the rest of the conventional forces to the B-1, so they could see the weapon system's inherent war-fighting capabilities and develop integrated tactics and doctrine for conventional employment. Loh opened up realistic combat training opportunities for B-1 units within elements of ACC such as the USAF Weapons School, and combat training exercises such as Red Flag. General Loh created a pathway for B-1 aviators to integrate with other conventional weapon systems and, in doing so, he created a culture of innovation within the B-1 community as its aviators sought to gain credibility and competency in conventional warfare.

Before the B-1 joined Air Combat Command, the weapon system was not allowed to participate in Tactical Air Command's premier combat training exercise known as Red Flag, flown in the Nellis AFB training ranges.[57] B-1 units had almost no experience with conventional training exercises until Loh directed their integration into the Red Flag training. There were, however, several B-1 crews that had trained with the Navy at the Fallon Nevada training ranges several years prior to integrating with Red Flag. Although this training provided an excellent opportunity for the small number of B-1 crews certified for conventional tactics, it did not occur often enough to have a noticeable impact on the B-1 community. Moreover, the lessons learned during these exercises were not passed on to the B-1 training units where new B-1 aviators were certified to fly the aircraft and new instructor qualifications were given.[58] Once training at Red Flag began, B-1 units were forced to acknowledge shortcomings in communications, force integration, and conventional bombing tactics and training. The B-1s did not perform well according to Colonel Eldon Woodie. Despite being extremely competent, professional, and courageous nuclear warriors, the B--1 aviators needed a lot more conventional training in order to integrate with the tactics of a conventional force package.[59]

Integrating into the Air Force Weapons School helped the B-1 community transform its weapon system for conventional missions more than any other

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[57] Colonel (ret) Eldon Woodie, interview by the author, 13 Feb 2010, TAC and SAC did not correlate training or exercises.
[58] Colonel (ret) Eldon Woodie, interview by the author, 13 Feb 2010. 9th Bomb Squadron Commander from August 1999 to Aug 2002.
[59] Col (ret) Eldon Woodie, interview by the author, 13 Feb 2010. B-1 Instructor Pilot 1987-2002. 9th Bomb Squadron Commander from August 1999 to Aug 2002.

factor.[60] In 1992, Loh invited the first B-1 class to join the Weapons School ranks in order to provide a pathway for B-1 officers to integrate and gain credibility with other fighter and combat weapon systems.[61] The first graduating B-1 class validated the course curriculum and served as the initial cadre for the B-1 Weapons School division. The six-month Weapons Instructor Course charged each graduating aviator to return to an operational squadron to teach and instruct their home squadron on the tactics, capabilities, and skills learned throughout the course. According to former B-1 weapons school division commander Brigadier General Stephen "Seve" Wilson, the young captains graduating from the school "led the charge and fired up the rest of the community to see the vision of great ideas and innovation emerging in the B-1 community."[62] Colonel David "Gunny" Been graduated from the second B-1 Weapons School class. He experienced the change in training and in culture that emerged with graduates of the school. He viewed the school as the catalyst for the culture shift taking place at the time in the B-1 community—moving away from the regimented requirements of employing nuclear weapons under Strategic Air Command to a tactically flexible and adaptable conventional ready force.[63] Exposure to the experience and tactics of other combat aviation units in the weapons school taught the B-1 community the power of integrating airpower capabilities, according to Wilson; the B-1 weapons officers took the best and brightest ideas, and adapted them to the B-1, which moved the

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[60] Brig Gen Stephen Wilson, interview by the author, 24 March 2010. Additionally, almost every former squadron commander interviewed believed the Weapons School influence fostered a complete change in the B-1 aviator's mindset and unit culture, which is viewed today as a tactically flexible and adaptive culture. Interviews with Col Been, Brig Gen Wilson, Brig Gen Clark, Col Pryor, Col Brunner, Col Woodie, and LtCol Garrett.

[61] General (ret) John Michael Loh, interview by the author, 7 April 2010. As Air Combat Command stood up in 1992 after the dissolution of Strategic Air Command and Tactical Air Command, the Fighter Weapons School embarked on a dramatic shift from its 43-year focus exclusively on fighter aviation, dropping "fighter" from its title and becoming the Air Force Weapons School. USAF Weapons School History. Accessed online at: http://www.nellis.af.mil/library/factsheets/factsheet.asp?id=4098.

[62] Brig Gen Stephen Wilson, USAF, 379 AEW/CC, interview by the author, 25 March 2010. Wilson commanded the B-1 division of Weapons School from 1997-1999.

[63] Colonel David "Gunny" Been, 379 EOG/CC, interview by the author, 22 March 2010. Col Been served as the 37 BS/CC from 2005-2007 and now commands the Operations Group in Al Udeid, Qatar.

community toward effective conventional warfare employment.[64] Many of those innovative ideas and tactics developed, tested, and taught by the B-1 division of the weapons school were what made the B-1 successful during later combat experiences. The B-1 weapons school instructors and students also influenced other Air Force combat units; they boosted the B-1 community's credibility and exposed the larger Air Force to the B-1's capabilities according to General Loh.[65]

Another opportunity for the weapon system to integrate with the rest of the combat Air Force and prepare for its new conventional mission was with the 366th Composite Wing at Mountain Home AFB, Idaho. The Air Force formed the 366th in 1991, declaring it would become the Air Force's premier "air intervention" wing.[66] The composite wing was Air Force Chief of Staff McPeak's idea, he believed that creating composite wings, where one commander would control all types of combat aircraft, would streamline and shorten tactical planning.[67] General McPeak expressed that a composite wing would make "smaller mistakes because it works and trains together in peacetime ... it knows the playbook ... in other words, it can exploit the inherent flexibility of airpower."[68] The 34th Bomb Squadron transferred its operations from Ellsworth AFB to Mountain Home AFB in April 1997.[69] Referred to as the Mountain Home experience, "which in many ways was a Red Flag environment occurring every day," the 366th provided the perfect environment for B-1 crews to progress as tactical aviators.[70] By integrating with the Mountain Home wing, with its

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[64] Brig Gen Stephen Wilson, USAF, 379 AEW/CC, interview by the author, 25 March 2010. MDS refers to each specific aircraft or that aircraft's community of aircrew, maintainer, and capability.
[65] General (ret) John Michael Loh, interview by the author, 7 April 2010.
[66] 366th Fighter Wing History. Accessed on 25 March 2010 at: http://www.mountainhome.af.mil/library/factsheets/factsheet.asp?id=4278
[67] 366th Fighter Wing History. Accessed on 25 March 2010 at: http://www.mountainhome.af.mil/library/factsheets/factsheet.asp?id=4278
[68] 366th Fighter Wing History. Accessed on 25 March 2010 at: http://www.mountainhome.af.mil/library/factsheets/factsheet.asp?id=4278.
[69] 366th Fighter Wing History. Accessed on 25 March 2010 at: http://www.mountainhome.af.mil/library/factsheets/factsheet.asp?id=4278
[70] Brig Gen Stephen Wilson, USAF, interview with the author, 25 March 2010. Brig Gen Wilson believes the 34th Bomb Squadron capabilities were equal to any other combat aviation squadrons in the Air Force during the time they flew with the Mountain Home Composite Wing. He stated the change in capability stemming from the 34 BS was positive because of the greater understanding of Airpower that the wing provided.

mixture of fighter, bomber, and tanker aircraft, B-1 crews built a strong reputation for being tactically knowledgeable and flexible with the F-15E, F-15C, F-16, and A-10 units .[71] Aviators and commanders in the Composite Wing soon learned to respect the B-1 and it soon gained combat credibility. This credibility progressively expanded to senior Air Force leaders at Air Combat Command and in the Pentagon.[72] The aviators assigned to the 34th Bomb Squadron, as well as the larger B-1 community, secured trust and confidence needed to ensure senior leaders would call on them when the nation went to war.

While innovative ideas and tactics grew out of the Mountain Home experience and with the integration into the USAF Weapons School, there were other B-1 squadrons developing innovative ideas and tactics as well. The Kansas and Georgia Air National Guard (ANG) units were each assigned 12 B-1 aircraft in 1996 as part of the active duty force reduction measures intended to reduce annual budget requirements for Air Combat Command. Experienced fighter pilots from the Navy and Air Force in these guard units brought a distinctly different culture of training, tactical flying, and conventional weapons employment into the B-1 community. Their methods of training and tactical flexibility were very different from the SAC experience carried over from the aviators on active duty, most of whom were previous B-52 aircrew selected to fly the B-1 by special selection boards.[73] The Kansas and Georgia ANG developed new ideas and realistic training methods quickly because of their previous experience, and they developed a culture of innovation and flexibility that sparked a competitive atmosphere between them and the active duty units.

A competitive culture between B-1 squadrons helped to spur new tactics and raised professional standards within the community. Rivalry between

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Col James A. Pryor, interview by the author, 21 March 2010. The Mountain Home experience invoked a confidence in the B-1 aviators assigned to the wing making them very effective in large force composite employment tactics similar to the employment methods seen during air campaigns such as Desert Storm. The composite wing B-1s were the first units to deploy in the Fall of 2001 allowing the wing to validate their composite force training and tactics.

[71] Col James "Hook" Pryor, USAF, 34th BS/CC, interview by the author, 21 March 2010.

[72] Brig Gen Stephen Wilson, interview by the author, 24 March 2010.

[73] Col David "Gunny" Been, USAF, 379th EOG/CC, interview by the author, 22 March 2010.

organizations within the B-1 community created a culture in which anyone subscribing to the old way of doing things quickly earned the stigma of being 'dinosaurs' in the fleet. This competiveness appeared during formal training such as instructor courses and operational exercises involving multiple units. Innovative ideas using new technological systems and tactics emerged from this competitive culture. Within this competitive environment, the B-1 training squadron at Dyess AFB had a reputation as being dinosaurs. Some aviators in the Guard and Weapons School units jokingly called the training units at Dyess the "Abyss," where many good ideas went in but never came out. The B-1 training squadron at Dyess frequently considered any innovative tactic or idea as too risky to pursue or implement as Woodie, then a Lt Col and instructor pilot with the B-1 Formal Training Unit (FTU), recalled.[74] The training units had reason to remain conservative in their tactics even though other B-1 squadrons were pushing the limits of tactics. In 1997, a B-1 from Ellsworth AFB crashed during low-level maneuvering, killing all four crewmembers. An investigation later revealed that the aircrew was practicing a complicated threat-reaction maneuver that exceeded their aircraft's design limits.

Despite strides made with the Weapons School and at the Composite Wing in gaining respect for their conventional integration capabilities, stagnant perceptions, biases and competing programs at the Air Staff and ACC often stifled B-1 progress.[75] Few officers with B-1 experience sat on General Loh's staff. Additionally, most of the Air Force's senior leaders with bomber backgrounds had retired. Although Loh had a fighter background, he argued he was the only general officer advocating for the B-1 bomber in Air Combat Command and on the Air Staff as well.[76] After several B-1 base visits and demonstration flights, Loh commented, "apparently my staff doesn't know as

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[74] Col (ret) Eldon Woodie, interview by the author, 13 Feb 2010. 9th Bomb Squadron Commander from August 1999 to Aug 2002. 5th Bomb Wing Command from 2006 to 2008.

[75] Col (ret) Eldon Woodie, interview by the author, 13 Feb 2010. One of the first pilots selected to fly the B-1 immediately after his first assignment as an instructor pilot at UPT. Col Woodie led the 9th Bomb Squadron from 1999 to 2002. He commanded the 5th Bomb Wing from 2005 to 2006.

[76] Interviews with General Loh, Colonel Eldon Woodie, and Brigadier General Steve Wilson by the author.

much as they should about your current B-1 capabilities."[77] He also once remarked to Wilson, after a demonstration flight, "I want to know legitimate reasons why we cannot let some of these innovations take place, such as putting laptop computers or targeting pods on the aircraft."

The B-1 weapon system lost its greatest advocate when General Loh retired in late 1995; support for the B-1 on the Air Staff and at ACC waned. Loh's replacement, General Hawley was not as supportive for the B-1. As a Lt Col, Wilson and other weapons officers at ACC tried to develop a targeting pod for the B-1, but the notion was quickly dismissed with the response that pods were something only fighter aircraft needed. The B-1 community feared that if its nuclear mission were taken away, their weapon system would be vulnerable for an early retirement. The Air Force planned to keep the new B-2 stealth bomber along with the stand-off-cruise-missile-carrying B-52, leaving the B-1 as an easy kill for an Air Staff searching for ways to cut budgets. The perception of being on the verge of cancellation stressed the changing B-1 organization; it always needed to prove its worth and ability. To show their merit, B-1 organizations felt compelled to be better than their contemporaries were during the countless training exercises and readiness inspections. They had to prove their ability to integrate tactically with conventional forces in theatre warfare. Brigadier General Steve "Seve" Wilson called it the "we're second best and we work twice as hard" attitude prevalent throughout the B-1 community then.[78] Many in the B-1 still believe that senior Air Force and Department of Defense leaders did not recognize the potential in the B-1 until after September 2001.

Regardless of those perceptions, General Loh's vision for the B-1's role in conventional warfare helped the weapon system to integrate with the conventional force. The force integration training and the conventional munitions upgrade program provided B-1 aviators and commanders with the confidence that they were ready to demonstrate their capabilities in their new mission. That confidence led them to believe they knew something the rest of the Air Force did not about their capability, according to Wilson, "it was not a

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[77] Col (ret) Eldon Woodie and Brig Gen Stephen Wilson, interviews by the author, Feb and March 2010.
[78] Brig Gen Stephen Wilson, interview by the author, 25 March 2010.

matter of if but when the rest of the combat air force would recognize the inherent capabilities of the airframe, the tactics, and the B-1 community of aviators and maintainers."[79] One of the numerous skirmishes in the No-Fly Zones over Northern and Southern Iraq soon provided the weapon system that opportunity.

Operation Desert Fox

Operation Desert Storm ejected the Iraqi Army from Kuwait, but flight operations enforcing the United Nations-designated no-fly zones in northern and southern Iraq continued for over a decade. Throughout that period, numerous skirmishes between Saddam Hussein's forces and Air Force, Navy, Marine Corps, and Royal Air Force aviators occurred under the backing of Operations Northern Watch and Southern Watch. One such skirmish in December 1998, named Operation Desert Fox, served as the B-1's combat debut as it participated in a four day air campaign against the Iraqi regime.[80] This four-day air campaign sought to punish Saddam Hussein and his regime for its refusal to comply with the demands of weapons inspectors from the United Nations, who were searching for materials relating to the development of nuclear, biological or chemical weapons. The strikes targeted 28 surface-to-air missiles and integrated-air-defense facilities, 19 regime security installations, five airfields, 23 command and control facilities, and eight Republican Guard barracks.[81]

B-1 crews launched from Bahrain on their first-ever combat strike missions on day two of Desert Fox to target the Al Kut barracks housing the Al Nida Republican Guard division northwest of Baghdad.[82] One B-1 squadron from Ellsworth AFB and one from Dyess AFB had deployed to Bahrain in November of 1998. They combined as part of the 366th Air Expeditionary Wing.[83] Crews began training immediately and prepared for the upcoming operational missions until training flights ended on December 15. Operation Desert Fox began on the following day. Although the B-1 employed

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[79] Brig Gen Stephen Wilson, interview by the author, 25 March 2010.
[80] Thomas Withington, *B-1 Lancer Units In Combat,* ed. Tony Holmes (New York: Osprey Publishing Limited, 2006), 36.
[81] Withington, *B-1 Lancer Units in Combat*, 37.
[82] Withington, *B-1 Lancer Units in Combat*, 38.
[83] Withington, *B-1 Lancer Units in Combat*, 36.

conventional capabilities in its combat debut, it did not employ precision-guided weapons. Hitting the Republican Guard was supposed to drive a wedge between them and the regular Iraqi Army, and encourage the latter to rise against Saddam. In a press conference following the Al Kut attack, Rear Admiral Thomas R. Wilson, vice director for intelligence for the Joint Chiefs of Staff, noted that the weapons used by the B-1 were not precision guided: "It was the old way, although it's hard to beat a lot of bombs sometimes. The crew walked a stick of bombs across the Al Kut barracks, successfully hitting and destroying sections of each building on the target list."[84] The B-1's conventional combat debut supporting Operation Desert Fox legitimized the community's years of transformation; it also provided many lessons learned from the expeditionary deployment.[85]

B-1 commanders and experienced aircrew members identified two particular areas they needed to improve. The first involved standardizing their employment procedures, and second, commanders recognized the aircraft lacked some of the technological capabilities needed to integrate with the combat air force. These deployed squadrons discovered a lack of standardization within the B-1 community. The in-theater training flights leading up to the first combat missions exposed, and even exacerbated, the tactical employment differences between these B-1 units.[86] Commanders of the mixed squadron deployment recognized that the B-1 community needed to standardize its employment procedures and improve the crosstalk across all B-1 squadrons.[87]

Operation Desert Fox also taught the B-1 deployed commanders and experienced aircrew that the B-1 weapon system's conventional transformation was incomplete; this experience exposed technological limitations in its conventional capabilities. The weapon system was not ready to deliver new precision-guided munitions, and it lacked the ability to assess the battle

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[84] Anthony H. Cordesman, *Iraq in Crisis: A History from Desert Fox to June 1999* (Washington, DC: Center for Strategic and International Studies, 1 July 1999), 10.
[85] A lesson learned is defined as an insight gained that improves military operations or activities at the strategic, operational, or tactical level and results in long-term, internalized change to an individual, group of individuals, or an organization.
[86] Col (ret) Eldon Woodie, interview by the author, 13 Feb 2010.
[87] Col (ret) Eldon Woodie, interview by the author, 13 Feb 2010.

damage it could inflict. This experience taught its aircrews that they needed on-board sensors to record weapon releases and their subsequent impacts on their targets. During Operation Desert Fox, the B-1 did not drop precision or terminally controlled weapons, and the system could not assess the battle damage it created with on-board sensors and recording equipment, either while in flight or afterwards. During the Al Kut barracks strike, an escorting F-14 recorded the weapons impact. An Offensive Systems Operator provided the only onboard post strike record his B-1 crew could use to assess success when he used a handheld camera to photograph the radar scope just prior to release on their bomb run.

Fighter pilots, at the time, found it absurd that a strike aircraft could not record targeting data with onboard systems that recorded aircraft displays and radar during release and weapon impact. To make matters worse, Desert Storm had conditioned the general public to expect images of precision laser guided munitions hitting their targets. Wilson used Desert Fox as a foundation for his consistent requests to ACC attempting to gain support for funding a targeting pod on the B-1. Since he could not convince the fighter-focused command to place a high priority on a bomber's targeting pod, his bids were quickly dismissed. The B-1 community unfortunately, would have to wait nearly ten more years before mounting a targeting pod that could record and share such images.

Continuing CMUP Development

The Air Force continued modifying the B-1's conventional capabilities through the CMUP. The service expected to receive its first three JDAM-equipped aircraft one month after sending the two B-1 squadrons to support Desert Fox in November 1998. The Block D aircraft modification was considered a critical phase for the B-1 transformation. Modifying the entire fleet was not scheduled for completion until late 1999; however, as part of the original CMUP contract, Congress provided funding for the first seven aircraft to be outfitted and ready 18 months early for operational testing. While the two units were deployed to Bahrain, engineers finished Block D's development and modified the first aircraft with new hardware and software. Following modifications, the Air Force had to test and evaluate the modified aircraft, and

test the advanced munitions under operational conditions, before the service would let its transformed bomber deliver near-precision weapons.

The Air Force received its first three Block D equipped aircraft one month after sending the B-1 squadrons to support Desert Fox. As part of the Block D modification, the Air Force planned to upgrade the standardized weapons software and hardware architecture, install anti-jam data and voice radios, and integrate GPS receivers into its INS system. The standardized architecture would provide the system's first precision weapon capability by integrating the newest GPS-guided weapon, the Joint Direct Attack Munition. The new anti-jam radios ensured secure communication capability between B--1 aircraft and other airborne aircraft in the type of force packages common to conventional tactics at the time.

Block D also introduced a new towed decoy system; this was the first phase of upgrades to the defensive systems upgrade DSUP, which was separated from the offensive CMUP contracts in 1995. The decoy system was reeled out on a Kevlar lanyard behind the aircraft in-flight and towed to provide added protection against modern surface-to-air missile threats. The towed decoy would prove more than effective during the next B-1 combat employment. In the spring of 1999, shortly after the test squadron received the remaining four of the first seven newly modified Block D aircraft; B-1 units were called to war again to support combat operations in Kosovo against Slobodan Milosevic's Serbian military.

Operation Allied Force

Outcry within the international community over alleged ethnic cleansing against Kosovo's Albanian population led to American involvement in the Balkans in the spring of 1999. The United States, along with the North Atlantic Treaty Organization (NATO) forces, conducted a series of air strikes that tried to remove the Serbian military from Kosovo, or deny its ability to keep abusing the people of Kosovo. The Supreme Allied Commander in Europe, General Wesley Clark, commanded the campaign and very clearly wanted NATO forces to stop the violence and restore peace. Clark set the objectives for the Balkans air campaign involving ten NATO country members and France by declaring, "we're going to systematically and progressively attack, disrupt, degrade, devastate,

and ultimately, unless President Milosevic complies with the demands of the international community, we're going to destroy his forces and their facilities."[88]

The air campaign, named Operation Allied Force, put the newest B-1 Block D aircraft through the ultimate operational test—actual combat. The CMUP upgrades installed in the B-1 over the previous five years were the primary reasons the aircraft was ready and able to integrate successfully with the US-led NATO air campaign. Prior to the outbreak of hostilities, Air Combat Command had offered a B-1 expert from its headquarters staff, Major Mark "Pacman" Schlichte to assist in planning at US Air Forces in Europe (USAFE) headquarters, Germany, and USAFE later moved him forward to the air operations center in Vicenza, Italy. General John Jumper, the USAFE commander felt strongly about how to use the B-1 in the pending campaign. While walking briskly through the bustling headquarters mission planning area, Jumper noticed a B-1 silhouette on the nametag of an officer trying to catch his attention. Schlichte began trying to convince the general that the B-1 could support the planned campaign, but the general cut him off, warning him that if the B-1s wanted in the fight, they had to be modified with the new Block D towed decoys. In a parting shot as the general stepped away for his next briefing, Jumper advised Pacman that B-1s would not be around in the Air Force much longer if they missed the Kosovo fight. Schlichte got the message loud and clear and passed it back to ACC and the B-1 community. [89]

The Block D upgrade was delivered just in time. Although all of the first seven Block D aircraft were modified, which included the defensive towed decoy system, they were still being delivered to the B-1 operational test and evaluation squadron, the 337th Test and Evaluation Squadron, to undergo final flight testing. Getting the seven newly modified aircraft ready for deployment and combat operations required greatly accelerating the final Block D preparations, according to Colonel Anthony F. Przybyslawski, Commander of the 28th Bomb Wing during OAF.[90] One particularly important software update was still needed to ensure the towed decoy system could counter the expected threats in

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[88] Withington, *B-1 Lancer Units in Combat*, 40.
[89] Lt Col (ret) Mark Schlichte, interview by the author, 2 March 2010. Referenced from Schlichte's experience in April through June of 1999.
[90] Withington, *B-1 Lancer Units in Combat*, 41.

the Balkans Theater. The 53rd Test and Evaluation Group (TEG) at Eglin AFB, Florida, had written the software, and was preparing to upload the update on the aircraft and then verify the new mission data software on the range. Although the software had already been written, getting test aircraft modified and range verification completed typically took weeks or even months to complete, but the Ellsworth, Edwards, and Eglin test teams only had days. Despite the challenge, the 36th Engineering and Test squadron began testing the software on 27 March, completed laboratory testing on 29 March, and finished flight testing 24 hours later—completing the updates in 100 hours.[91] Once the updates were validated, the 53rd TEG flew a modified B-1 to the Eglin test facility range to verify that the new systems operated correctly against simulated threats.

Once the ALE-50 Towed Decoy software was verified, Air Combat Command deployed five B-1s to Fairford RAB, United Kingdom to support OAF. The aircraft left on 29 March from Ellsworth, AFB, along with two C-5 Galaxy airlifters carrying support equipment and maintenance personnel. On 2 April, within 24 hours of arrival, B-1 crews were flying their first combat sorties into Kosovo against the Novi Sad petroleum production facility at Pancevo, northeast of Belgrade.[92] The target needed to be struck with area bombing, and the B-1 was perfect for that job. During the 78-day air war, the B-1 flew just over 100 combat sorties.[93]

On one particular mission, B-1s were tasked to strike Novi Sad, two aircraft were flying in formation when they made one pass over the target, each dropping 84 500-pound bombs and easily destroying key nodes of the petroleum plant which supplied the bulk of the Serbian army's fuel and oil requirements. However, during the bomb run the aircraft were targeted by a Serbian surface-to-air missile. The aircraft defeated the missile tracking them through defensive maneuvers, chaff, and ECM but were forced into another missile's radar engagement zone, forcing a secondary threat reaction and subsequent missile defeat. Although the aircraft deployed to Fairford Royal Air Base, United Kingdom, were modified for precision weapons carriage, they did

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[91] Withington, *B-1 Lancer Units in Combat*, 41.
[92] Withington, *B-1 Lancer Units in Combat*, 44.
[93] Lt Col David "Gunny" Been, interview by the author, 24 March 2010.

not release any. For the entire war B-1s were limited to the legacy 500-pound non-precision gravity weapons.[94]

The biggest concern the Joint Forces Air Component Commander, Lieutenant General Michael Short, and the USAFE Commander, General Jumper had with the B-1 was not knowing if the aircraft could survive the surface-to-air missile threats in the theater.[95] Lt Gen Short was given strict operational guidance to avoid losing any aircraft to enemy fire. He was very concerned that the electronic protection on the B-1 aircraft was insufficient and that the towed decoy performance was still unknown. Short became even more concerned after several missiles were launched at B-1s during the first missions they flew.[96] He believed that he could only manage the threat risks by limiting the operational area for the B-1 to fly in. Despite his concerns, there were times when the B-1 became the go-to platform due to weather restrictions on laser weapons or targeting pods. On one occasion in particular, B-1s were tasked to release a string of bombs through a low cloud deck, obscuring targets for all aircraft using targeting pods, onto a ridgeline separating Albanian Muslims and Serbian soldiers. After monitoring the mission from the Air Operations Center in Vicenza, General Short told Schlichte it was the most accurate area bombing he had ever seen.[97]

Jumper attributed the B-1's successes and many missile defeats to the towed decoy's successful employment. He recalled another successful B-1 mission: "The pair of B-1s came down south over the Adriatic Sea in formation, with their ALE-50 towed decoys deployed, and we watched the radars in Montenegro track the bombers as they turned the corner around Macedonia and headed up into Kosovo. We watched the radars, in real time, hand off the targets to the SA-6s, which came up in full-target track and fired their missiles. Those missiles took the ALE-50s off the back end of the B-1s just like they were designed to do. The B-1s went on and hit their targets."[98] Allied Force was a proving ground and a turning point for the B-1 conventional mission. It

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[94] This is likely due to the limited availability of the JDAM, for most of OAF, the B-2 was given priority of the new weapon, which was reportedly in short supply.
[95] Conversation with General Short at SAASS on 30 April 2010.
[96] Conversation with General Short at SAASS on 30 April 2010.
[97] Lt Col (ret) Mark Schlichte, interview by the author, 2 March 2010.
[98] Withington, *B-1 Lancer Units in Combat*, 46.

showed that a small fleet of B-1s added significant capability to any conventional conflict. Colonel Been believes the jet came of age in Allied Force: "It was our first opportunity for sustained operations, which we were able to demonstrate we could perform. It really justified the jet. That probably ensured that we stayed around for years to come."[99]

Conclusion

The changes in mission, organization, training, and weapon system technology provided a window for innovation, and the opportunity for the B-1 weapon system to develop flexible, learning organization attributes that enabled a successful transformation. Once senior leaders such as General Loh provided the catalyst for upgrades and organizational support, the B-1 community grew into a learning organization developing new tactics, techniques, and procedures that assured it would integrate well with the conventional war-fighting forces. They worked to create a new set of operational tasks for the B-1, relevant to the new capability and organization within ACC. The standardization that had been inherent within SAC seemed to be gone, and a new identity within each squadron was emerging. In many ways, the pendulum had swung in the opposite direction from the strict procedures of SAC to a less formal, but more flexible, style of planning and employment. Although the influence of the USAF Weapons School was crucial to the development and abilities of the conventional force, the SAC standards of employment and procedural knowledge had been replaced by what many called a strictly tactical culture focused on pushing the limits of the aircraft and its weapons to better prepare airmen for the risks and demands of combat. Allied Force was in many ways the combat proving grounds of the peacetime conventional transformation – it sparked the engine of innovation and momentum toward further success.[100] After years of skepticism, political scrutiny, and limited growth in capability, the B-1 community was gaining momentum and influence by bringing a distinct capability to any Air Component Commander in a conventional war. The community was in many ways an agile, learning organization; upgrades and

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[99] Withington, *B-1 Lancer Units in Combat*, 41. Col David Been, interview by the author, 24 March 2010.

[100] Brig Gen Stephen Wilson, interview by the author, 25 March 2010.

weapons improvements, as well as better training and combat experience, were increasing its capabilities rapidly.

Chapter 3

ADAPTING IN IRREGULAR WARFARE

> *In this type of war you cannot – you must not – measure the effectiveness of the effort by the number of bridges destroyed, buildings damaged, vehicles burned, or any of the other standards that have been used for regular warfare. The task is to destroy the effectiveness of the insurgent's efforts and his ability to use the population for his own ends.*
>
> —General Curtis E. Lemay

This chapter documents the wartime military innovation in the B-1 weapon system. It provides a case study of how the Air Force orchestrated change in its organization, training, tactics, and aircraft technology under the urgency of war and as military strategy changed.[1] Stephen Rosen argues that if the pursuit of existing performance goals during wartime does not lead to success, and the military solution requires developing completely new capabilities to solve or overcome the problem, innovation is necessary and possible.[2] Military organizations use strategic measures of effectiveness to determine how day-to-day military operations are achieving or realizing strategic goals and to assess the appropriateness of their actions.[3] Military organizations frequently must innovate in wartime when they recognize that no matter how well they employ their old ways of war, they are still not going to win the war. Once the military organization recognizes they have been pursuing inappropriate strategic goals, they must define new strategic goals and capabilities.[4]

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[1] Robert Longley. "Rumsfeld Will Not Alter DoD Transformation: Modernized Military Key To Future of War On Global Terrorism." *About.Com.* 12 August 2002. http://usgovinfo.about.com/library/weekly/aa081202a.htm?p=1. The DoD recognized the need for adaptation and modernizing the US military. Then Secretary of Defense Donald Rumsfeld claimed it was critically important to the success of the global war on terrorism.

[2] Rosen, *Winning the Next War*, 30.

[3] Rosen, *Winning the Next War*, 30.

[4] Rosen, *Winning the Next War*, 35.

IRREGULAR WARFARE

The Global War on Terror is rooted in the war-torn regions of Afghanistan. Through the mid-1990s, Afghanistan remained volatile and riddled with strife following the 1989 withdrawal of Soviet forces. The post-withdrawal instability continued largely because of the competing interests of numerous factions and regional warlords. Because of the turmoil, the Afghan central government in Kabul remained weak and ineffective. It did not have enough loyal troops or party members to defeat the warring factions, or maintain governance throughout sizable regions of the country, which led to the disintegration of the government.[5] Instability and war provided fertile ground for terrorist groups to train and hide; it also provided a window of opportunity for an ideological movement of young religious zealots from southern Afghanistan to emerge as the reigning power.[6] The chaos from within the country coupled with "waning U.S. interest in the region" permitted Mullah Muhammad Omar to gain power and recognition as the "Commander of the Faithful," leader of the band of Islamic students who called themselves the Taliban.[7] The Taliban movement rippled across Afghanistan starting in 1996, and by 2001 they controlled nearly the entire country.[8] As the Taliban gained influence, they established Sharia law throughout most of the provinces. They also supported Osama bin Laden and his international jihadist network, al Qaeda, leaving their regime vulnerable to retaliation from the United States after the al Qaeda terrorist attacks on the Pentagon and in New York City.

The attacks marked a change in the nation's security environment similar to the context of the changes after the end of the Cold War. These shocking events of 11 September 2001 put the United States on notice that nontraditional, non-state actors and transnational issues, like immigration, drug trafficking, crime, famine, epidemics, and religious fanaticism threatened its national security interests; nation-states could no longer ensure the security

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[5] Seth G. Jones, *In the Graveyard of Empires: America's War in Afghanistan*. (New York: W.W. Norton & Company, Inc., 2009) ,49-51.
[6] Jones, *In the Graveyard of Empires*, 53.
[7] Jones, *In the Graveyard of Empires*, 53.
[8] Jones, *In the Graveyard of Empires*, 67.

and stability of the international system on their own. In response to these startling events, the United States embarked upon a Global War on Terror.

The Global War on Terrorism (GWOT) began with the rapid overthrow of the Taliban regime in Afghanistan, and spread throughout many other regions of the globe—anywhere terrorist organizations were found to have ties to Osama bin Laden's al Qaeda network. Since then, the United States has remained engaged in a complex irregular war designed to suppress terrorist organizations and insurgencies.[9] This effort invoked all elements of airpower, which served as supporting elements to the Joint Force Commander's ground campaign. Using modern airpower in small wars or in counter-insurgency (COIN) is not unprecedented; use of bombers in irregular warfare was common in Vietnam.[10] Since the start of operations in Afghanistan, the B-1 weapon system has proven itself effective and adaptable at supporting coalition forces in their efforts to find, deter, and suppress terrorist organizations and insurgents.

The US military changed its strategic measures of effectiveness in both Afghanistan and Iraq during various phases of the GWOT. The B-1 weapon system adapted to the changes in strategy and tactics; in some cases these adjustments required new technologies to remain effective at achieving the new objectives. The changes in mission objective called for the B-1 to conduct new tactical missions, also during that time, the weapon system received three major block upgrades, which included avionics, weapons, sensors, and communications modifications, enabling it to improve its capabilities and realize shifting measures of effectiveness to achieve strategic objectives.

The B-1's transformation occurred progressively over eight years of wartime operations. Three distinct periods of innovative change, however,

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[9] AFFDD 2-3 Irregular Warfare, "Irregular warfare encompasses a spectrum of warfare where the nature and characteristic are significantly different from traditional war. It includes, but is not limited to, activities such as insurgency, counter-insurgency (COIN), terrorism, and counterterrorism."

[10] Col John D. Jogerst, USAF (Ret), "Preparing for Irregular Warfare: The Future Ain't What It Used to Be," *Air and Space Power Journal*, 1 December 2009, Accessed online at: http://www.airpower.au.af.mil/airchronicles/apj/apj09/win09/jogerst.html. In the COIN environment, airpower allows friendly forces to see, move, and shoot, enabling them to dominate insurgents stuck on the ground. Airpower enables small units operating in complex terrain to create, occupy, and exploit the high ground. See also: Robert M. Kipp, "Counterinsurgency from 30000 Feet: The B-52 in Vietnam," *Air University Review*, Jan-Feb 1968, Accessed online at: http://www.airpower.maxwell.af.mil/airchronicles/aureview/1968/jan-feb/kipp.html.

classify the shifting missions and changing measures of effectiveness placed upon the aircrew and aircraft. The shifts in mission objectives provided opportunities and urgency for the organization to innovate. The first period was the initial stage of operations in Afghanistan, which focused on routing the Taliban and al Qaeda from their sanctuaries. The B-1 proved that it could meet the strategic measures of effectiveness set forth by the Combined Forces Air Component Commander (CFACC), Lieutenant General Moseley. He relied on long-range strike to provide persistent airpower, capable of striking targets identified by Special Operations Forces throughout Afghanistan using precision weapons.[11] The second period of change occurred from 2003 to 2006, during the height of Operation Iraqi Freedom (OIF) and while operations continued in Afghanistan. During OIF, B-1 aircrew developed and executed special anti-Scud/anti-weapons of mass destruction tactics in western Iraq. The B-1 capabilities and tactics satisfied the CFACC's requirements for Time Sensitive Targeting (TST) by providing a rapid re-targeting capability using precision weapons. Finally, the third period began after 2006, in Afghanistan and Iraq. As insurgency threatened stability in both theaters, the United States shifted strategies by focusing its combat air support on supporting counter-insurgency tactics, compelling the B-1 to adapt.

The upgrades and technological changes on the aircraft were important to the B-1's success. One particular innovative technology was the aircrew-developed laptop system modified for use in the cockpit. This modification eventually proved the quickest way to upgrade the aircraft with a targeting pod—crucial to the B-1's effectiveness in its later irregular warfare missions. The modification, nicknamed 'Grumpy Jet,' provided many innovative tools which enabled the weapon system to adapt and remain effective across the three strategic periods in the shifting irregular warfare environment.

In 2006, the newly assigned CFACC, Lt Gen Gary L. North, recognized that the B-1 could better support counter-insurgency tactics if it had an

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[11] Persistence and responsiveness were two key attributes that made the B-1 successful in irregular warfare. Typically a single B-1 could be called on to provide air-to-ground support in any area of Afghanistan relatively quickly which was considered an effective economy of effort. The study completed by Air Combat Command determined that the B-1 was the most cost effective provider of munitions in a cost per target DPI for a mission. 2003 ACC cost effectiveness staff briefing in author's possession.

electro-optical sensor targeting pod. He committed to modifying the B-1 with a targeting pod, claiming it was his number one tactical priority. Less than two years later, engineers completed modifying the B-1 with a targeting pod. Just as the modification was completed, the strategy in Afghanistan shifted, calling for fewer kinetic strikes and more focus on supporting ground elements with non-traditional intelligence, surveillance, and reconnaissance (NTISR) missions.[12] With the new equipment and aircrew training, the B-1 weapon system successfully adapted to remain effective in its mission supporting COIN. The B-1 proved capable of performing as a flexible and adaptable weapon system through each collective period of operations in Afghanistan and Iraq. As the measures of success determined by the JFACC and the strategic environment shifted, the weapon system adapted to these conditions. This technological innovation enabled the airmen employing the aircraft to achieve their objectives as the strategic measures of effectiveness changed.

OPERATION ENDURING FREEDOM (2001-2002)

> *It is entirely appropriate for us to suggest that the B-1, as we employ it today, is transformational – certainly not because it is a new system but because we are using it in ways never conceived of previously and gauging our success in terms of battlefield capability.*
>
> *--Former Secretary of the Air Force, James G. Roche*

On a cool and overcast night, just a few weeks after the terrorist attacks on the World Trade Center and the Pentagon, Captain Chris "Miles" McClung watched as the US military prepared to respond to the 9/11 attacks. McClung, a B-1 Weapons System Officer, had never seen a B-1 flight line as busy as that night at Ellsworth AFB. He arrived the previous night with three crews from Dyess AFB who had flown three B-1s in to support the 34th and 37th combined squadron combat deployment. The flight from Dyess was also the first time

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[12] United States Department of the Army, *The U.S. Army and Marine Corps: Counterinsurgency Field Manual* (Chicago: University of Chicago Press, 2007) 367. The field manual describes the use of high-tech airpower and targeting pod equipped aircraft as being very effective during COIN strategies. It recognizes aerial surveillance platforms with long loiter times as capable of placing an entire region under constant surveillance. Also, Tactical Control Parties now provide commanders with Beyond Line of Sight awareness with ROVER (remote operations video enhanced receiver), which links ground parties to aircraft equipped with targeting pods.

young Captain McClung had flown a B-1 loaded with 24 live 2000-pound JDAM on-board. Once they arrived, the Dyess crews provided as much support for the launches as they could; they loaded three of the deploying aircraft with their off-the-shelf laptop computer equipment and custom-made aluminum shelves designed to support the laptop in the B-1 cockpit. After loading the aircraft with their gear and laptop computers, McClung watched the aircraft taxi and launch—he knew it was history in the making.

> Watching twelve B-1s taxi to the end of the runway that night, and then hearing the deafening roar as each one of them lifted off right across the ramp from where we stood, on the roof of the Ellsworth Pride Hangar, it was incredible to see—it was history in the making. As each aircraft disappeared into the low cloud deck, you could still see the glow of the aircraft's afterburners, and then another jet would be lifting off again. It took less than eight minutes but it was one of the most amazing experiences of my career… I hoped for their success and was glad to assist the launches. At the same time, I wished I were going to war with them. I knew, though, that this deployment was something much bigger than just me. Knowing that their aircraft were loaded with live weapons, and that they would be airborne for more than twenty hours before reaching their forward operating location, made it even more impressive.[13]

On 7 October 2001, US aircraft began bombing al Qaeda training bases and strongholds while simultaneously striking Taliban fortifications across Afghanistan. The operation was a swift campaign to achieve a single objective: defeat the Taliban and destroy al Qaeda by capturing or killing bin Laden and other key leaders.[14] American Special Forces working alongside Northern Alliance forces, and cooperating with Central Intelligence Agency (CIA) operatives, called in Navy and Air Force strike aircraft to suppress al Qaeda groups seeking sanctuary in distant regions of Afghanistan. This unique combination of airpower, CIA and Special Ops teams, and Northern Alliance forces swept the Taliban from power and ousted al Qaeda from their safe havens within two months—while minimizing American casualties.[15] By

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[13] Major J. Chris "miles" McClung, interview by the author, 20 March 2010.
[14] John F. Kerry, *Tora Bora Revisited: How We Failed To Get Bin Laden and Why It Matters Today*. A Report to Members Of The Committee On Foreign Relations United States Senate. John F. Kerry, Chairman One Hundred Eleventh Congress First Session 30 November 2009.
[15] Kerry, *Tora Bora Revisited*, 30 November 2009.

December 2001, American civilian and military leaders celebrated what they viewed as a lasting victory with the selection of Hamid Karzai as the country's new democratic leader.[16]

During the earliest stages of this engagement in Afghanistan, and later in Iraq, the United States called upon its strategic bomber force to integrate with joint and coalition ground forces as part of the main airpower effort.[17] In a somewhat ironic twist of fate, the squadrons first deployed against terrorism during OEF could trace their heritage back to the 34th and 37th Bomb Squadron 'Doolittle Raiders' who first struck the Japanese homeland following Pearl Harbor.[18] Instead of providing only a psychological boost for a stunned America, these crews also struck significant military blows against al Qaeda and the Taliban during the initial phases of their engagement in Afghanistan.

From October to December 2001, B-1 crews flew only five percent of the combat missions yet struck 40 percent of the targets and dropped 70 percent of the precision weapons.[19] As the campaign progressed, B-1 and B-52 bombers effectively used smart weapons to perform close air support missions, protecting military ground forces engaged with the enemy.[20] Impressed by their precision and support to ground elements, Major General Walter E. Buchanan, Deputy Chief of Staff for air and space operations at the Pentagon, remarked "the B-1 bomber brings lots of muscle to the fight because of its long loiter time above the target area and high payload. So now we're talking about 24 JDAM for each aircraft, as opposed to fighters going in with, at best, typically four

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[16] Kerry, *Tora Bora Revisited*, 30 November 2009.
[17] Major Jeffrey W. Decker, "Return of the Bomber Barons: The Resurgence of Long-Range Bombardment Aviation for the Twenty-First Century," *Air and Space Power Journal,* (Summer 2005), 13.
[18] The initial airstrikes designed to route the Taliban from their Afghanistan strongholds were flown in part by B-1s from the 34th Bomb Squadron and the 37th Bomb Squadron as a combined deployed unit. Later, additional B-1 squadrons began continuous expeditionary rotations which continue today.
[19] History of the Aeronautical Systems Center, October 2000-September 2002. Volume 1 – Narrative. AFHRA, Maxwell AFB, AL. Call no. K215.12 v.1. Also see, Walter Boyne, "Phoenix Rising: The Transformation of the Boeing B-1," *Flight Journal*, April 2005, 39 and Withington, *B-1 Lancer Units in Combat*, 51.
[20] Kerry, *Tora Bora Revisited*.
See also, Maj Jeffrey W. Decker, USAF, "Return of the Bomber Barons: The Resurgence of Long-Range Bombardment Aviation for the Early Twenty-first Century," *Air & Space Power Journal*, Summer 2005.
http://www.airpower.au.af.mil/airchronicles/apj/apj05/sum05/decker.html

JDAM and not nearly as much loiter time."[21] Throughout the previous decade most Air Force leaders had not envisioned using the B-1 as a platform suited for this type of irregular warfare tactics.[22]

The B-1 community attributes their early successes in Afghanistan to the fielding of two weapon system innovations—JDAM and the Block D aircraft upgrade.[23] Although the squadrons flew nearly the same Block D configured aircraft as aircrews flew two years earlier in OAF, they were now carrying precision-guided JDAM instead of 500-pound gravity bombs.[24] Block D modifications also provided the capability to carry other variations and combinations of cluster munitions.[25]

Amidst the combat demands of routing the Taliban and al Qaeda from their sanctuaries, B-1 crews developed unique techniques and procedures for employing the JDAM in ways not anticipated prior to Afghanistan. Mission planners attempted to provide ground force commanders with as many weapon options as possible by carrying multiple fuse combinations on each launcher. Many of the strike requests from joint terminal air controllers (JTACs) called for combinations of airburst, penetrating, or impact-fused weapons on each mission. The combination of weapons and fuses provided the JTACs with

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[21] Withington, *B-1 Lancer Units In Combat*, 51.

[22] The B-1 still had the strategic, fixed target typecast associated with it's mission and aircrew capabilities. Brig Gen Stephen Wilson, Col Eldon Woodie, and Col David Been, interviews by the author, Feb to March 2010.

[23] Col Chris Brunner, interview by the author, 4 March 2010. Block D and JDAM integration, when coupled with the ARC-210 radio which provided voice satellite and secure UHF, VHF, and FM radio communication is the significant innovation from the peacetime CMUP that made a significant impact on the relevancy of the B---1 in irregular war. The 1760 data bus was the technological innovation that made the jet capable of delivering precision munitions and exploiting its long loiter capability over all areas of Afghanistan.

[24] Following the Gulf War, the Pentagon ordered the creation of a new, all-day, all-weather pinpoint munition that could be guided by a satellite-based Global Positioning System. It insisted that the new weapon be created out of old fashioned gravity bombs to save money. The result was the Joint Direct Attack Munition (JDAM): a $20,000 kit that, when attached to the tail of a free-fall bomb, could maneuver to a target by adjusting its fins to correct its course, using constant position updated from orbiting satellites. If the GPS failed to lock on, the kit had a built in inertial navigation system, an electrical gyroscope, that could strike the coordinates programmed from the launching aircraft.

[25] B-1B Conventional Mission Upgrade Program: "Final Operational Requirements Document," ACC/DRPB, "B-1 Conventional Upgrade Program; Revision 1" 19 Dec 1994, Iris Archive AFHRA ACC history K401.01 v.1 Supporting DocumentB-232.

multiple options but taxed aircrews planning bomb runs in-flight. Calculating the release sequence was a complicated weapons management task for the offensive systems operator, especially when crews released on multiple impact points simultaneously during a single target-area pass. Within the first few weeks of combat, B-1 aircrew compensated for the complexity by creating quick-reference cards to help them determine release stations and tolerances in flight.

Although all B-1 aircrew were trained to employ JDAM, these weapons were so new to the Air Force inventory that few B-1 crews had released actual live or inert weapons before deploying for Afghanistan. Their JDAM training involved simulated releases using the aircraft's simulated software mode. Mission planning for releasing the new weapons was straightforward, and in-flight launching of the weapon on the B-1 was also relatively simple - it required the aircrew to input accurate target coordinates and terrain elevation into each weapon prior to release. Accurate in-flight navigation assured accurate coordinate handoff to the weapon's computer. Once the handoff occurred and the weapon exited the bomb bay, special lift-producing strakes on the munition's body increased its glide distance while its guidance computers controlled three fins on the tail-kit assembly to maneuver the weapon to the desired impact point.

Launching from the multi-purpose rotary launcher (MPRL) on the B-1 added an element of difficulty to JDAM releases. Each weapon on the launcher had to be in the down-facing position and ready for release while the aircraft was still inside the launch acceptability region (LAR), which was calculated by the offensive avionics according to distance to the target, aircraft speed and altitude. The release mechanism on the B-1 rotary-launcher required from four to nine seconds to rotate to the next available weapon for each subsequent release in a single weapons bay. Although three bays of weapons shortened this timeline, there was often time to release only three or four weapons before the aircraft was past the LAR parameters. Further complicating the release planning was the placement of the different weapon-fuse variations on the launcher. A desired weapon-fuse combination could often be blocked by another incompatible weapon-fuse combination. Because the fuse settings

could not be changed in-flight, computing weapon availability was challenging for the Weapons System Officer trying to program weapons releases as quickly as possible once the crew received a call for simultaneous multiple target strikes.

Afghanistan's mountainous terrain also complicated and limited the release parameters for the JDAM. After weapon release, the JDAM's computer attempted to hit targets at a pre-set impact angle, but the high elevation of the mountains limited the time of fall and maneuvering energy for the flight path of the JDAM from B-1 employment altitudes. If the aircraft was too slow or too far off angle from the target, the weapon could not maneuver to reach the target.

The simplicity of the weapon system's on-board computer and displays did not make this challenge any easier for B-1 aircrews in 2001 and 2002. The Block D weapon-status and release-parameters display used to determine the acceptable LAR depicted only an entry point and countdown timer for an exit point. This caused diminished situational awareness when releasing JDAMs, especially during multiple near-simultaneous weapons releases. The Block D weapon-release displays also complicated the employment of JDAM because there was no LAR display to monitor the dynamic release conditions for multiple simultaneous weapon launches. Furthermore, the avionics software did not display which type of fuse was set on each of the launcher's eight stations, making it difficult for aircrew to select the appropriate station for release when a specific fuse was required. Block D avionics software was further limited to carrying the same type of weapon carriage system in each bay.[26] Although the B-1 crews were capable of employing both versions of JDAM very successfully during OEF, the Block D avionics software inadequately depicted the dynamic LAR information for the complex environment and situational awareness requirements of combat operations.

Although the aircraft deployed for OEF were generally as capable as those that deployed for OAF, they did lack an electronic email data-link system

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[26] The capability to carry dissimilar types and weight class weapons in different bays was not added to the B-1 until Block E which was operational in 2005. The B-52 at the time carried 12 JDAM and required each to be the identical class of weapon, e.g. version 3 or version 1 JDAM. This limitation meant that cave-busting weapons had to be loaded specifically for sorties in advance, whereas a mixed load of weapons types and fusing provided the aircrew and JTAC additional choices in-flight.

that had been installed earlier for testing purposes. This equipment and capability had been removed from the aircraft shortly after OAF. To compensate for the missing moving map capability, a few innovative weapons officers bought off-the-shelf laptop computers and linked them up to handheld commercial GPS receivers. They then developed a method to splice the handheld GPS antennae cable into the internal GPS antennae on the Block D aircraft.[27] The officers then configured the aft weapons systems officer station with laptops and pre-loaded every aviation chart available with flight planning software and aviation charts. Once the laptops were connected to the improvised GPS receiver and antennae unit, the system provided crewmembers a "bird's eye" visual depiction of the aircraft in relation to the battle space with GPS accuracy—greatly enhancing their situational awareness. This laptop configuration became the test bed for new ideas and innovations for B-1 crewmembers and enhanced B-1 flexibility in combat.

What began as an ad hoc solution soon became a powerful in-flight situational awareness tool, unanimously considered by crewmembers as an essential addition to the long duration combat flights into Afghanistan. Since it was nearly impossible to maintain maps and charts of all of the areas where the B-1 operated in Afghanistan on each mission, crews loaded satellite imagery, various scales of aviation and terrain charts, and additional software programs for managing weapons patterns onto a laptop, the laptop was part of the 'Grumpy Jet' laptop modification on the B-1. The in-flight real-time moving map and accompanying database of imagery and charts quickly turned the ad hoc computer arrangement into a must-have instrument for every flight.[28]

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[27] Lt Col (ret) James "Grumpy" Wiegle, interview by the author, 19 Feb 2010. The laptop configuration on the B-1 became known as the "Grumpy Jet" modification. The laptops were stowed on the defensive systems officer workstation until several squadrons had custom aluminum and wood laptop shelves designed and installed under the aft station avionics panel. Eventually, the laptop configuration was networked to a second laptop that controlled an LCD display in the front pilot station of the aircraft. Later, in 2006, the laptop configuration became the method of integrating and controlling the Sniper targeting pod that the CFACC, Lt. Gen Gary North, requested for all B-1 aircraft in the CENTCOM Theater.

[28] Lt Col (ret) James "Grumpy" Weigle; original developer of the in-flight moving map capability on the B-1. As the jets were in pre-flight prior to a mission, crews ensured that each of the software programs and chart databases were operational on the laptops. Mission Planning Cells loaded all of the reference materials and briefing materials from Intelligence sources so crews could operate in any region of the country

The on-board laptop computers provided a medium for developing innovative tactics, techniques, and procedures rapidly during combat operations. For example, crews had to load individual coordinates for each GPS-guided munition, even when area targets called for the release of multiple munitions. In these cases, ground forces typically only passed a single coordinate set, but expected munitions dispersal across a large area. Major James "Grumpy" Weigle, attending ACSC at the time, helped deployed B-1 squadrons develop a software program on the laptop that converted a single coordinate set into a dispersed area pattern with multiple coordinates for weapon inputs.[29] His software program was quickly tested and approved for use in-flight.[30] This capability allowed crews to compute target pattern coordinates in-flight for multiple weapon releases, what they eventually called "pattern managing." Pattern management in the B-1 would become an important tactic during future close air support missions and time-sensitive targeting in Iraq. This capability was eventually integrated into the offensive avionics several years later as part of the Block E upgrade.[31]

The pattern management program soon became the 'Grumpy Jet' system's 'killer app', letting in-flight B-1 crews respond to the combat needs of ground controllers requesting special weapons dispersal patterns and effects. The ability to pattern manage with the laptop computer program quickly gained credibility as it met the combat needs of ground controllers requesting special weapons effects from B-1 crews. One of the enduring images of operations in Afghanistan showed American Special Operations tactical air controllers on horseback, riding side-by-side with their Northern Alliance partners, directing precise air strikes against al Qaeda positions.[32] "The picture that is etched into

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with up-to-date materials. This was uncommon for most combat platforms in theatre which mainly relied on their pre-mission briefing for specific tactical level information that was valid for only a small area of operations. The smaller cockpits and single or two man crews did not have the same ability to dedicate time toward referencing new information in-flight while enroute to another operating area.

[29] Lt Col (ret) James "Grumpy Weigle, interview by the author, 19 Feb 2010.

[30] Lt Col (ret) James "Grumpy Weigle, interview by the author, 19 Feb 2010.

[31] Lt Col (ret) James "Grumpy Weigle, interview by the author, 19 Feb 2010. Also from an interview with Dave "Spock" Webb, who programmed and modified the Grumpy pattern management software to fit the changing needs of the B-1 crews, 19 Feb 2010.

[32] Tony Capaccio, "U.S. Horse Soldier Tells How He Helped Direct Aghan Air War," *Bloomberg.com*, 20 Mar 2002. Air Force Secretary James Roche and Chief of Staff Gen.

my mind about the B-1," bragged Major General Daniel P. Leaf, director of operational requirements for air and space operations at the Pentagon, "is the picture of an Afghan mountainside and a string of GBU-31 JDAM marching down a trench line. If you had offered me the B-1 with JDAM as a solution ten years ago, I would have laughed heartily because it is not what we envisioned. However, faced with a shift in what we have to do, we adjusted and used the airplane in an extraordinarily flexible manner over Afghanistan.[33]

B-1 crews used 'Grumpy Jet' to calculate the coordinates for many similar JDAM strikes. The aircrew first used imagery and terrain data on the laptop to display the target described by ground commanders, they then used the pattern management software to derive a linear string of coordinates, which the crew then entered into each individual weapon. Without the laptop, the crew would have had to calculate each impact point individually using on-board radar targeting procedures, or have JTACs or the Air Operations Center provide them over radio links.

This enduring image of the linear burst of JDAMs across the trench line epitomized an airpower transformation that the B-1 weapon system facilitated. Instead of considering what a specific aircraft platform could contribute, airmen began to consider how airpower could deliver specific effects on specific targets using specific types of weapons.[34] B-1 aircrews developed a new way to employ their weapon system using the ad hoc laptop computer system that took advantage of the variety of weapons this aircraft could carry and its persistent loiter time. One Pentagon official remarked "the massed JDAM employment by the B-1s played a very big part in the routing of the Taliban and al Qaeda. When you're able to precisely drop a series of weapons like that, it is really something; it's truly transformational in a combat sense."[35]

John Jumper repeatedly referred to Staff Sergeant Mathew Lienhard's tale as emblematic of a service using old tactics and new equipment to improve mobility and killing power. Lienhard directed air strikes from B-1 and B-52 bombers and Navy F-18 and F-14 fighters. He stated, "once the Northern Alliance commanders saw the first precision airstrikes with the laser –guided bombs and JDAMs—we were able to hit bunkers very precisely—they became believers and we were very much in demand."

[33] Major General Daniel P. Leaf, director of operational requirements for air and space operations at the Pentagon. Withington, *B-1 Lancer Units in Combat*, 52.

[34] Brig Gen Stephen Wilson, interview by the author, 25 March 2010. 379th AEW/CC, Al Udied, AB Qatar.

[35] Major General Leaf quoted in Withington, *B-1 Lancer Units in Combat*, 52.

Tailor-made for the type of operations in Afghanistan, the B-1 weapon system was a key enabler of the innovative strategy of success[36] In mid-December, 2001, General Jumper commented on the successes of the bombers in Afghanistan. "Some missions had pre-planned targets ranging from troops to tanks to command posts. Later, the bomber crews received fresh intelligence en-route, requiring them to throw out their original attack plan and plan in-flight. The B-52s take off, and they don't know what their targets are going to be until they arrive. We are inventing these tactics more or less in the course of battle so we get this job done."[37] Jumper also acknowledged the innovative methods of the B-1 when he gave credit to bomber operations during other interviews. He lauded Army General Tommy Franks, commander of Central Command, for letting the Air Force innovate in Afghanistan. "Franks let us put things together in the course of battle—many of these techniques unproven—and they have been extremely successful. The B-1s and B-52s take off and they don't know what their targets are going to be until they arrive over Afghanistan. We've got them doing flexible targeting like an A-10 does in close air support, and accuracy has increased."[38]

The B-1 remained deployed through the spring of 2002. Colonel Eldon Woodie led the B-1 squadron that was on-call during Operation Anaconda; B-1s under his command delivered over 2,000 JDAM during the three-week operation. B-1s were overhead waiting to help the night two CH-47s were shot down, but their lack of an onboard imaging sensor to help them see ground movements prevented them from aiding the downed crews. Moreover, these B-1s were only carrying 2,000-pound weapons at

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[36] Peter Pae, "Maligned B-1 Bomber Now Proving Its Worth," *The Los Angeles Times*, 12 December 2001. See also, William M. Arkin, Special to The Times, "Old-Timers Prove Invaluable In Afghanistan Air Campaign: Though Pentagon wants funding for new fighter planes, B-1 and B-52 come out on top in a numerical analysis of bombing," *Los Angeles Times*, Feb 10, 2002.

[37] General John Jumper, CSAF, quoted in Eric Schmitt and James Dao, "The Air Campaign: Use of Pinpoint Air Power Comes of Age in New War," *New York Times*, 24 December 2001, AFHRA SD III-32.

[38] David A. Fulghum and Robert Wall, "Heavy Bomber Attacks Dominate Afghan War: New real Time targeting, plus long endurance, has recast the bomber fleet as a full-time battlefield menace," *Aviation Week & Space Technology*, 3 December 2001. AFHRA K215.17 v.6 SD III-33.

that point in OEF—not a particularly good choice of precision weapon for close air support in instances such as the Chinook shoot downs. Once bombers were tasked to assist in Anaconda, Woodie's squadron proved very flexible and adaptable as they changed their method of employment to meet their assigned objectives. Over the following three weeks, hundreds of JDAM were dropped over the whaleback mountain saturating the battlefield. Many taskings also called on the B-1 to continue working with ground controllers targeting mortar positions, machine gun nests, and al Qaeda hidden in cliffs and caves around the whale.

Using the long range bomber to support irregular warfare represented an innovative change. Long-range bombers combined flew just 10 percent of the strike missions, yet they delivered 11,500 of the 17,500 total munitions dropped in Afghanistan.[39] By February of 2002, more than 65 percent of the total weapons delivered, and 89 percent of all weapons delivered by the Air Force, were released from heavy bombers. The B-1s role early in OEF represented five percent of the missions but over 40 percent of the munitions released in 2001 alone, by the end of 2002 the weapon system earned the reputation as a vital workhorse for the war in Afghanistan.[40] The initial phase of Operation Enduring Freedom proved convincingly that the B-1 weapon system could perform close air support missions and re-target in-flight effectively.[41] Its performance set the stage for it to play another crucial role in the Global War on Terror over Iraq.

The B-1 was a true workhorse for the Air Force in late 2001 and 2002. However, deployed aircrews and military planners recognized opportunities to improve the weapon system's ability: smaller weapons would have been better, an EO/IR targeting pod would help the system's responsiveness, and the ability to record weapon releases and impacts

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[39] William M. Arkin, "Old-Timers Prove Invaluable In Afghanistan Air Campaign," *Los Angeles Times*, 10 February 2002. AFHRA K215.17 v.6. SD III-36.
[40] Decker, "Return of the Bomber Barons." He cited "Operation Enduring Freedom: The Air Campaign," at Efreedomnews.com, 12 January 2003, http://www.efreedomnews.com/News%20Archive/Afghanistan/AirZ%20War.htm.
[41] David A. Fulghum and Robert Wall, "Heavy Bomber Attacks Dominate Afghan War," 3 December 2001. AFHRA SD-III-33.

would help post-mission analyses. Recording weapon and targeting pod footage was a debriefing tool common in fighter communities and generally expected by the public when discussing capabilities of modern combat aircraft. Not having a video recording of their weapon impacts made it difficult for Air Force planners to assess results. It was more difficult and certainly less interesting to report on bomber missions than reporting to news networks using the targeting pod video from laser-guided weapons striking targets precisely under the electronic crosshairs of a targeting pod—a capability the media was accustomed to since Desert Storm. Although the B-1 community had transformed their weapon system for conventional war and successfully demonstrated its performance during irregular warfare, it still wanted to incorporate more capabilities to boost the system's flexibility.

B-1 CONSOLIDATION AND MODERNIZATION

After being nominated as Secretary of Defense in early 2001, Donald Rumsfeld declared his commitment to transform the American military during his confirmation hearings, stating American military innovation was too slow for modern technological change.[42] He stated, "The pace of new weapon development has become slower, while the pace of technological change has become far more rapid. These two opposite trends conspire to create a situation where it is difficult for the acquisition process to produce anything other than capabilities that are already a generation behind when deployed.[43] The secretary of defense was determined to "move forcefully to rationalize the costly burden of force structures and practices that did not contribute to current and future U.S. security needs."[44] Shortly after his confirmation, Rumsfeld began pushing for accelerated military transformation by using a small team to review defense requirements.[45] The team submitted its findings

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[42] Jim Garamone, "Rumsfeld Details DoD Goals, Objectives in Testimony: Speeding Up Research, Development and Acquisition One of Rumsfeld's Five Key Objectives," *Program Manager* (January-February 2001): 2-4 Sup Doc II-3.
[43] Quoted in "Rumsfeld's New Order," *Air Force Magazine* (May 2001), Sup Doc II-15.
[44] "Rumsfeld's New Order," *Air Force Magazine* (May 2001), Sup Doc II-15.
[45] "Struggling for Transformation," *Air Force Magazine* (May 2001), Sup Doc II-15.

in May 2001, just in time to influence the ongoing Quadrennial Defense Review for 2001.[46]

As his first order of transformation, he recommended cancelling the B-1 program.[47] During his push for transformation, Rumsfeld said that the B-1 was "not viable in a conflict today" and that it was "headed toward expensive obsolescence."[48] Secretary of the Air Force James Roche and CSAF John Jumper faced a difficult balancing act – they had to modernize the system's cockpit and weapons to make it relevant for Rumsfeld's vision of a transformed military, yet each knew the Department of Defense would not fund those upgrades. They could only afford to modernize the system by cutting the size of the operational B-1 fleet to pay these bills.

The plan they worked out involved consolidating the fleet from 93 to 60 aircraft based at one or two operational bases. Retiring 33 aircraft would provide savings the Air Force could use to fund the much needed upgrades.[49] They 'sold' their plan to Rumsfeld and directed the B-1 weapon system to begin consolidation plans within the year. By the summer of 2002, the B-1 fleet was reduced to 60 aircraft. Jumper explained this rationale as he testified before Congress during his confirmation hearings in

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[46] General Accounting Office to the Chairman and Ranking Minority Member, Committee on Armed Services, U.S. Senate, "Quadrennial Defense Review: Future Review Can Benefit from Better Analysis and Changes in Timing and Scope," GAO-03-13, November 2002, Sup Doc II-16.

[47] GAO Report to the Honorable Max Clelend, U.S. Senate, *Force Structure: Review of B-1 Process Identifies Opportunity to Improve Future Analysis*, September 2002. SD III-48, AFHRA K215.17 v.6.

[48] James Dao, "Rumsfeld Will Call For Big Cut In B-1 Bombers, Official Say," *The New York Times*, June 27, 2001. The B-1 community's frustration during this time period was manifest when Secretary of the Air Force James Roche and Lt General Michael Moseley, OEF CFACC, visited the Airbase in Thumrait, Oman in early 2002. In a question and answer session with the secretary, one captain asked Secretary Roche to comment on what Defense Secretary Rumsfeld thought of the B-1 now that it had proven effective in an extended combat role. Secretary Roche explained that Rumsfeld indeed had wanted the program cancelled, but that Roche and Moseley successfully convinced him the B-1 could be a formidable platform if given the proper cockpit and weapons upgrades. The consolidation of the B-1 fleet from 93 to 60 aircraft intended to free up program budget money to re-invest toward those upgrades, Major J. Chris McClung, interview by the author, 20 March 2010.

[48] James Dao, "Rumsfeld Will Call For Big Cut In B-1 Bombers, Official Say," *The New York Times*, 27 June 2001.

[49] Robert Wall, Washington. "B-1 Fights Demotion In Combat Role." *Aviation Week & Space Technology*, 24 June 2002, 47. AFHRA K215.17 v.6, SD III-47.

July 2001.[50] He stated that he supported the weapon system and wanted to upgrade it to make it more viable now and in the future. He stated in October 2001 that he fully supported the decision to cut the B-1 fleet because of the $2.2 billion needed to make the entire fleet fully combat-capable: "by going from 93 to 60 [aircraft] we are able to close the funding gap." He then argued "now we have to make sure we are paying attention to finding the mobile/reloadable target in bad weather that has always been our problem."[51]

As the war in Afghanistan progressed, Air Force leaders continued to consolidate the B-1 fleet, yet criticism for the decision increased. A September 2002 General Accounting Office report criticized the Air Force for the B-1 reduction plan and its potential impact on the Defense Department's ability to meet wartime requirements.[52] Moreover, congressional leaders with constituents hosting B-1 bases and other bomber advocates chafed at the Air Force's reluctance to tout the combat effectiveness of bombers over fighters during OEF. They believed Air Force leaders were "fearful of criticism over the B-1 decision now that it proved itself as a star player in Afghanistan."[53] Although Rumsfeld later admitted the value of the heavy bomber during OEF, he remained committed to his military transformation agenda, which would oust Cold War relics and doctrine in order to invest in more agile and flexible forces.

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[50] "The New Chief," *Air Force Magazine,* Vol 84, No, 10, Oct 01, 1-10. According the General Jumper, the decision to consolidate B-1s was a monetary one. The money saved from consolidating the B-1 units onto two bases would be used to bring the remaining B-1 fleet up to current modernization levels. "With over $2 billion in unfunded requirements, we can pour money back into modernizing the remaining B-1 fleet."

[51] GAO Report to the Honorable Max Clelend, U.S. Senate, *Force Structure: Review of B-1 Process Identifies Opportunity to Improve Future Analysis*, September 2002. SD III-48, AFHRA K215.17 v.6.

[52] History of ASC, October 2000 – September 2002, K215.17 v.1, 65. SD III-48. See also Jefferson Morris, "GAO Criticizes Air Force on handling of B-1 consolodation," *Aerospace Daily*, 9 Sep 02, SD III-49.

[53] Peter Pae, "Maligned B-1 Bomber Now Proving It's Worth" *Los Angeles Times*, 12 December 2001. While military analysts say the B-1 appears to be the "star player in Afghanistan" the Pentagon has been reluctant to talk about it. Eight B-1s based on the Indian Ocean island of Diego Garcia are flying about four sorties a day dropping majority of the tonnage in Afghanistan, military sources say. But the Pentagon has steadfastly refused to provide details of the B-1's role.

The Secretary of the Air Force and General Jumper did not focus solely on the B-1 during late 2001. In October, amidst the B-1 consolidation controversy and ongoing combat operations, Secretary Roche directed a study on long-range bombers to update an existing 1999 white paper. The new bomber white paper called for further bomber force reductions, to 157 total aircraft in 2002.[54] The new study acknowledged the lessons of Yugoslavia and Afghanistan, stating the bomber force was just as likely to strike point targets or support ground troops as any fighter plane, especially in poor weather.[55] Furthermore, the report called for a variety of hardware and software improvements to keep the existing force capable and survivable. It stated that, "As a result of DoD transformation plans and recent operational experience (Air War over Serbia and Operation Enduring Freedom), portions of the 1999 U.S. Air Force White Paper on Long Range Bombers have become outmoded."[56] The white paper outlined the way ahead not only for the B-1, but also for the B-52 and B-2. Each bomber reportedly fit into the Air Force long-range strike requirements in a specialized and non-interchangeable role. The report shaped the technical requirements for further B-1 modifications and missions. Rumsfeld's desire to cancel the B-1 seemed to fade away in favor of the Air Force Secretary and CSAF plans to modify the B-1to fit the mission requirements laid out in the Long Range Strike White Paper. The B-1 weapon system prospered from the increased support and combat credibility by gaining developmental funding and a sense of urgency for the ongoing and future weapon system modernization efforts.

Air Force Material Command's Aeronautical Systems Center (ASC), the center responsible for developing, purchasing, modernizing, and sustaining airborne weapon systems, underwent a rapid transition into a wartime operational mode at the start of Operation Enduring Freedom.[57] Under

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[54] U.S. Air Force Long-Range Strike Aircraft White Paper. November 2001. AFHRA K215.17 v.6 SD III-43.
[55] Long Range Strike White Paper, November 2001. AFHRA K215.17 v.6 SD III-43.
[56] U.S. Air Force Long-Range Strike Aircraft White Paper. November 2001. AFHRA K215.17 v.6 SD III-43.
[57] History of ASC, From 2001 to 2002, AFHRA K215.17 v.1. Under President Bush's and Secretary of Defense Rumsfeld's banner of military "Transformation," ASC increased its focus on combining advanced technologies with innovation in strategy, tactics, and

Secretary of Defense Rumsfeld's military transformation initiative, the center focused on shortening its acquisition cycle times to support combatant commanders in a more timely manner. The B-1 System Program Office (SPO), already managing the long-term CMUP program, added the recently approved and urgent Air Force Secretary and CSAF modernization directives to incorporate any supported combat mission needs statements.[58] To address combat mission needs, the B-1 SPO quickly emphasized "lethality, survivability, supportability, and responsiveness," toward improving the B-1 fleet.

The B-1 SPO folded these new urgent priorities and any combat modification requests into the ongoing CMUP plan. The SPO accelerated existing block upgrade plans and added new capabilities to the CMUP design. Although Block D aircraft were being flown in Afghanistan, modifications were still underway on aircraft at the two remaining B-1 operational bases and were not scheduled for completion until the end of 2002. Officials at the SPO received approval to accelerate the procurement of the Block D, E, and F upgrades to improve combat capabilities in the field. By May 2002, all Block D modifications were completed and the SPO focused their efforts on the Block E and F upgrades.

These upgrades would change the aircraft significantly. Block E and F were the third and fourth block upgrades associated with the four phases of CMUP.[59] Many of the requested changes in avionics generated from combat operations were incorporated into the Block E upgrade. Block E would add significant enhancements to the weapons and avionics capabilities of the aircraft. The upgrade introduced four computers to replace the six existing computers controlling Controls/Displays, Guidance/Navigation, Weapon Delivery, Critical Resources Function, and Terrain Following. The SPO also

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doctrine to give the United States the operational edge, and an asymmetric advantage on the battlefield and in future conflicts... Secretary of the Air Force and General John Jumper directed the Air Force for Acquisition, Marvin Sambur, to "Change the way the Air Force does business to deliver capability to the war fighter war fighter in a timely, affordable manner."[57]

[58] Department of the Air Force Memorandum for ASC/YD. Subject: B-1 Conventional Munition Upgrade Program (CMUP) Semiannual Historical Report. 23 April 2001, AFHRA K215.17 v.6 SD III-38.

[59] Power Point Briefing by Col Mike Miller ASC/YD, "B-1 System Program Office: B-1 Program Update" 5 June 2002.

planned to install a new Data Transfer System and convert to new Avionics Flight Software (AFS). Block E enhancements would enable the B-1 to deploy three different types of weapons on a single sortie with only one software load. The block would also integrate the Wind Corrected Munitions Dispenser, the Joint Standoff Weapon, and the Joint Air-to-Surface Missile. The long-awaited Defensive System Upgrade Program (DSUP) would replace most of the ALQ-161 with an AN/ALR-56M Radar Warning Receiver and added RF countermeasures, including a Fiber Optic Towed Decoy (FOTD) during the Block F upgrade.[60] In June 2002, the first flight using Block E AFS successfully released three different types of gravity weapons on a single release. The aircraft carried a different type of weapon in each bay, achieving the milestone of being the first Air Force flight to release three different munition types against three separate targets on the same bomb run.[61]

The B-1 SPO initiated an innovative contracting strategy to help accelerate B-1 modernization as part of ASC's effort to cut acquisition cycle times. The strategy resulted in the B-One Next Enhancement (BONE) contract being awarded to the Boeing Company in late 2001.[62] Designed "to satisfy both currently programmed and future requirements," it was broadly scoped, of long duration, and let the SPO issue sole-source Indefinite Delivery/Indefinite Quantity task orders to Boeing.[63] The new program enabled the Air Force to modernize, upgrade, integrate, and sustain the B-1 more effectively as the "Backbone" of the manned bomber force.

The B-1 SPO used the BONE contract to support war fighters needs less than a year after awarding the contract. The Projects Division within the B-1 SPO felt that the weapon system could easily satisfy two Combat Mission Needs Statements issued by CENTCOM. According to Colonel Michael Miller, B-1

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[60] History of ASC, K215.17 v.1, 66.
[61] History of ASC, 68. On 2 May 2002, a Global Power Bomber Combined Test Force B-1 crew released one MK-84 2000 pound gravity weapons, three MK-82 500 pound weapons, and four CBU-89 1000 pound cluster munitions during a single 20 second bombing run. The weapons struck targets approximately 10,000 feet apart on the Edwards AFB test range.
[62] Memorandum For ASC/HO, from ASC/YD, 13 May 2002. Subject: Conventional Mission Upgrade Program (CMUP) Semiannual Historical Report. ASC History SD III-40.
[63] History of ASC SD III-39, Dec 4, 2001. The ceiling on the BONE contract was $4.5 billion for a single 15 year period.

System Program Director, the Beyond Line of Sight (BLOS) communications capability and the Situational Awareness Enhancement (SAE) capability upgrade requests were combined into a single task orders for the BONE contract.[64] Boeing began installing BLOS/SAE components in October 2002 and completed the upgrade less than one year later.[65]

Boeing met the BLOS/SAE requirements by installing a semi-permanent laptop system that largely replaced the ad hoc arrangement designed by the B-1 aircrew which was used in Afghanistan in 2001 and 2002. The new laptop system paved the way for more significant innovations using the on-board laptops in the future. The BLOS/SAE modification installed a laptop carriage surface, conditioned power supply; better integrated wiring to the GPS and other displays, and it added the CT-II satellite radio communication system. The CT-II satellite radio added secure email and displayed aircraft tracking on the laptops of airborne B--1s and squadron or Air Operations Center (AOC) ground stations.

During the B-1 weapon system's operational pause, the SPO also successfully accelerated the Block E computer upgrade by consolidating five separately managed and funded programs. The consolidation forged a single hardware and software baseline and eliminated multiple laboratory, flight-test, and fielded configurations.[66] The BONE contract essentially let the SPO field the original Block E upgrade one year early and at no additional cost due to this consolidation.

The good news about the Block E upgrade schedule was unfortunately offset by delays in the defensive upgrade program. The DSUP was being delayed because of the lack of maturity of the Fiber Optic Towed Decoy. Colonel Pete Knudsen, the B-1 DSUP program manager, informed ACC of the need to restructure the program in January 2002. The DSUP team began restructuring its developmental timeline in May 2002. By November, the schedule breach and restructuring was estimated to cost the program an additional $175 million. Knudsen reported that the five ALE-55

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[64] History of ASC , K215.17 v.1, 71.
[65] Memorandum For ASC/HO, from ASC/YD, 5 November 2002. AFHRA ASC History K215.17 v.1 SD III-41.
[66] History of ASC, K215.17 v.1, Memorandum for ASC/HO, 13 May 2002.

test sorties indicated the need to redesign the decoy system, causing the test team to doubt the ALE-55's ability to turn the corner and making it a "high risk" program.[67] By December of 2002, the Air Force announced that it was terminating the B-1 DSUP, citing "escalating schedule and cost growth."[68] Although further flight testing just before the decision to cancel showed significantly better results, these program funding decisions were not reversed.

The Block F DSUP problems raised questions within the Defense Department about the B-1 weapon system's future roles. Deficiencies in the program's ALE-55 test FOTD led some within the Air Force to suggest relegating the B-1 to a standoff role. Others, however, claimed that the B-1 could still fly over defended targets. Colonel Jason Xiques, the B-1 Weapons System Program Manager at ACC, argued that the savings realized by terminating the DSUP—some $635 million—could be reinvested in other B-1 programs, including improving the ALQ-161 electronic protection system, to make it more reliable and more survivable.

The years 2001 and 2002 were tumultuous ones for the B-1 weapon system as it experienced the threat of cancellation, wartime tasking and continued to develop major technologies. Without the weapon system's superior performance in combat, coupled with the support of senior leaders such as Secretary Roche and Generals Jumper and Moseley, the B-1 might have been mothballed. Secretary Roche remained committed to modernizing the aircraft by completing CMUP plans and further upgrades to enable the B-1 to meet the Long Range Strike requirements of the future.

OPERATION IRAQI FREEDOM

> *With intercontinental range, duration over a target area measured in hours, and the new tactic of stacking aircraft in benign areas for execution of time sensitive or emerging targets, the B-1 is now a theater weapon of choice.*

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[67] "B-1 DSUP Gets Lanced: Could the termination of the Defensive System Upgrade Program for the B-1 mean early retirement for the long range bomber?," *The Journal of Electronic Defense*, Febuary 2003. www.jedonline.com

[68] "B-1 DSUP Gets Lanced" *The Journal of Electronic Defense*, Febuary 2003. www.jedonline.com

--Secretary James Roche

Less than a year after B-1 squadrons returned home from OEF the community prepared to deploy again, this time to support pending operations in Iraq. To help prepare for the expected threats and to better support the pending airpower employment strategy, B-1 commanders developed specialized training and tactics with other Air Force units preparing to deploy.[69] B-1 crews flew sorties in the Nellis training range to refine tactics and skills alongside other air and ground components. This pre-deployment training focused on Time Sensitive Targeting (TST), seeking to minimize the time it took B-1 aircrews to detect and engage targets that might suddenly emerge on the battlefield. These efforts hoped to decrease the kill chain to find, fix, track, target, and engage emerging targets. TST would later emerge as the pre-dominant mission for the B-1 in Iraq.[70]

One of the priorities during OIF for Lt Gen Michael T. Moseley, as the Combined Air Component Commander, was to deny Iraq the ability to launch any Scud missiles into Israel or other neighboring countries.[71] Lt Gen Moseley received delegated responsibility to engage important emerging targets, such as Scud missiles and Iraqi leaders, from the Commander of US Central Command (CENTCOM), General Tommy Franks. Franks essentially pushed most of the authority for prosecuting the emerging targets down to the air component, he articulated his decision through a formal decision matrix which defined who could execute different categories of TSTs.[72] Military planners worried, before and during the war, that Iraq might use Scud missiles in western Iraq to attack Israel, especially as the international coalition prepared to confront the defiant Iraqi leader.

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[69] Colonel Gordon Mausolf, 37 BS/CC and 34 BS/DO during OEF and OIF, email correspondence with the author, 10 March 2010. In preparation for OIF and knowing there was a real threat of Saddam launching SCUDs into Israel, crews prepared for new Non-Traditional ISR (NTISR) missions, using specially designed Tactics, Techniques, and Procedures (TTPs).

[70] Brig Gen Richard Clark, 34 EBS/CC during OIF, interview with the author, 19 March 2010.

[71] Lt Col Michael W. Kometer, USAF, *Command In Air War: Centralized Versus Decentralized Control of Combat Airpower*. (Maxwell AFB, AL: Air University Press, 2009)173.

[72] Kometer, *Command In Air War*, 172.

To combat this threat, Gen Moseley and the AOC needed to decrease the time it took from gathering different component targeting requests to gaining approval to strike a high-value or time-critical target. He took the authority General Franks had delegated to him and entrusted it to the Time Critical Targeting (TCT) Cell chief on the combat operations floor.[73] This gave the Combat Operations Division of the AOC sufficient authority to accomplish things in real time. Moseley relied heavily on the significantly improved capabilities within the AOC air tasking systems to assign and prioritize targets and aircraft during OIF.[74]

The coalition's focus on TCT, in particular, the time sensitive targeting requirements needed to deny Scud capability, were successful. During the first days of OIF, the air component formed a joint "Time Critical Targeting" Cell that launched over 50 rapid-reaction raids in the first 21 days, some as quickly as 15 minutes from intelligence tip to bomb drop. Many aircraft, including B-1s, orbited over pre-assigned areas of Iraq where they awaited tasking from the AOC in Saudi Arabia. Nineteen surface-to-surface missiles were launched (none on Israel) in the 21-day campaign to reach Baghdad compared to 88 Scuds launched in a 43-day campaign in Desert Storm.[75]

The same flexibility displayed by the aircrew and aircraft that made the B-1 weapon system successful in Afghanistan would work even more effectively in Operation Iraqi Freedom. To counter the Scud threat in Western Iraq, B-1 crews would need to update their mission plans in-flight, departing from traditional planned flight paths with scheduled targets and adopt far more flexible mission procedures. Crews would launch with the latest intelligence and communications information, and then expect to receive specific target taskings in the air. They would then have to organize aircraft strike support packages to attack targets assigned by the AOC or ground commanders. Crews prepared to use the same methods to pass new target information in OIF as they had during OEF, the laptop secure email capability and satellite radios used. The situational awareness information available to the B-1 crews from

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[73] Kometer, *Command In Air War,* 171.
[74] Kometer, *Command In Air War*, 177.
[75] Kometer, *Command In Air War*, 172.

the laptop would be invaluable for in-flight strike planning after being passed new targeting instructions. For strikes where the objective, or measure of effectiveness, was to strike the target as rapidly as possible after the tasking, the laptop moving map displays provided instantaneous awareness of the airspace and aircrew's relationship to the target.

Brigadier General James M. Kowalski commanded the 405th composite wing which operated ten B-1s from Thumrait, Oman.[76] These aircraft were configured nearly the same as during the previous year in Afghanistan, except the SPO now supported the laptop computer system, which enabled quicker repairs and flight-line maintenance supportability. The 'Grumpy Jet' system, as it was still referred to, remained an invaluable situational awareness tool for B-1 crews as they were called on to re-plan missions in flight. On one such occasion, on the second night of combat operations, a B-1 with the call sign Walla 64 penetrated the most heavily defended area in Iraq and became the first B-1 to operate over downtown Baghdad.[77] Originally scheduled to target Republican Guard units south of Baghdad in support of the US Army 3rd Infantry Division, Walla 64 was redirected, just prior to taxiing, to strike six GPS jamming towers in the heart of Baghdad's Super MEZ (super missile engagement zone). Since most Coalition precision weapons relied on GPS for their accuracy, the GPS jamming towers had to be destroyed.

Walla 64's two pilots, Colonel Joe Brown and Captain Lee Johnson, navigated their way to the target area using night vision goggles while the two weapons system officers (WSOs), Captains Steve Burgh and George Stone, plotted targets on the laptop imagery and mapping software.[78] The flight north took two-and-a-half hours, time the offensive WSO needed to assign the newly received target coordinates to the correct weapon stations and allocate the 24 JDAM to ensure the destruction of the towers while minimizing the risk of collateral damage. No other strike assets were going downtown during the

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[77] Walter Boyne, "Phoenix Risen: The Transformation of the Boeing B-1," *World Aviation History*, accessed online at: http://www.wingsoverkansas.com. See also: Withington, *B-1 Lancer Units In Combat*, 72.
[78] Walter Boyne, "Phoenix Risen: The Transformation of the Boeing B-1," *World Aviation History*, accessed online at: http://www.wingsoverkansas.com. See also: Withington, *B-1B Lancer Units In Combat*, 73.

strike and intelligence reported the presence of SA-2s, SA-3s, and heavy anti-aircraft-artillery (AAA). To suppress enemy air defenses, two F-16CJs and two EA-6B Prowlers joined Walla 64 en-route.

Flying at 27,000 feet Walla 64 began its attack from the southeast corner of Baghdad. The city cast an illuminating glow from the lights shining through a scattered cloud deck below the aircraft. The defensive radar warning systems signaled that several surface-to-air missile radars were targeting the outbound aircraft after it struck its first target and began circling around north of the city. A salvo of six JDAM, according to plan, hit the first set of towers despite multiple AAA bursts all around the aircraft. Col Brown easily maneuvered the aircraft into a jink to avoid the AAA as he turned west through the center of Baghdad for the next target. Immediately after the last weapon released on the second target, Captain Johnson spotted and called out a SAM launch. Colonel Brown broke left as the defensive WSO released chaff and initiated electronic jamming.

On the third bomb run, the crew detected another SAM launch at their 4 o'clock position. Johnson broke away from the SAM and the AAA, as Capt Stone continued jamming and released chaff. The copilot watched as the missile drifted aft on the canopy and then disappeared above the aircraft. Walla 64 defeated four SAMs and evaded heavy AAA that night while successfully releasing 23 of its 24 JDAM against the six GPS jamming towers throughout downtown Baghdad.[79] A post-strike analysis credited Walla 64 with destroying four targets and lightly damaging a fifth, and GPS-jamming emissions ceased for the remainder of the war.[80]

The B-1 dropped 2,159 JDAM during Operation Iraqi Freedom, equating to forty-three percent of the total used. Although it only flew one percent of the sorties, it dropped twenty-two percent of the total guided weapons used during the campaign and destroyed ten percent of the targets. The mission against the GPS towers is representative of literally

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[79] Walter Boyne, "Phoenix Risen: The Transformation of the Boeing B-1," *World Aviation History*, accessed online at: http://www.wingsoverkansas.com. See also: Withington, *B-1 Lancer Units In Combat*, 73.

[80] Walter Boyne, "Phoenix Risen: The Transformation of the Boeing B-1," *World Aviation History*, accessed online at: http://www.wingsoverkansas.com. See also: Withington, *B-1 Units In Combat*, 73.

scores of similar B-1 missions flown during OEF. B-1 crews skillfully used the aircraft's much-maligned electronic jamming suite repeatedly to overcome Iraqi defenses and take out Iraqi targets. These crews also relied heavily on the laptop computer system for data communications and situational awareness throughout the battle space.

The B-1 weapon system also demonstrated its flexibility and innovative tactics against time sensitive targets later in the conflict; on the night of 7 April 2003 a B-1 was re-directed to a new high-priority target.[81] Intelligence had reported that Saddam Hussein and his sons were allegedly in a restaurant which the B-1 was now tasked to strike. The B-1 crew demonstrated just how fast the "kill-chain" could be when it struck the high-priority target just twelve minutes after receiving the tasking to launch four GBU-31 JDAM. Although Hussein and his sons were not actually in the restaurant at the time, the mission successfully demonstrated the B-1 weapon system's ability to strike time-sensitive critical targets, a strategic measure of effectiveness during the conflict.[82]

The B-1's success against OIF objectives —one of which was time between tasking and striking a target, or TST, prompted Air Marshal Sir Glenn Torpy, the Royal Air Force, UK Chief of Operations, to call the B-1 "the star of OIF." He was not alone in his praise, Lt Gen T. Michael "Buzz" Moseley, adamantly proclaimed "Quite simply, the 'Bone' was the most effective weapons system used during Operation Iraqi Freedom." He called the aircraft his "roving linebacker" and "weapon of choice," thanks to its flexibility, bomb-load, range, loiter time and its aircrew's willingness to "stick their noses in the fight."[83] The B-1 integrated conventional roles and tactics developed during its long peacetime conventional transformation with new systems and tactics employed in the early stages of OEF. It was proving an effective and flexible platform as it adopted new roles and then excelled at them.

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[81] Major Chris "Wacky" Wachter, interview by the author, 25 March 2010.
[82] Withington, *B-1 Lancer Units In Combat*, 75.
[83] Withington, *B-1 Lancer Units In Combat*, 69.

OPERATION ENDURING FREEDOM 2006 TO PRESENT

The B-1 was a platform, which carried an enormous amount of capacity, but it did not have the ability to see the enemy on the ground with an electro-optical or infrared capability like all of the other aircraft that we were flying overhead.

—General Gary L. North

From 2003 until just before 2006, the B-1 continued supporting operations in Afghanistan, and in some cases Iraq. During this period, the weapon system changed very little technologically. However, just before General North assumed command in 2006 as the CFACC, the B-1 weapon system changed more technologically in a short time period than at any other time during its conventional transformation.[84] Operations in Afghanistan were ongoing, yet the three operational squadrons transitioned into and trained with a new block upgrade for each six-month rotation. The B-1 weapon system was modified with the Block E and sustainment block SB-10, and SB-12 equipment, avionics software, and weapons upgrades. Squadrons returning from deploying in 2004 and 2005 immediately upgraded to a new aircraft configuration when they returned so they could prepare and train for their next deployment. A fast-paced qualification and proficiency-training program placed heavy demands on squadrons deploying shortly after their aircraft were modified. Commanders worried that their squadrons might not be thoroughly familiar with the new systems and weapons capabilities they would soon be taking into combat.[85]

The Block E modifications represented a quantum leap in computing capability, information management, and weapons innovations for the B-1 weapon system. Boeing completed the Block E avionics modification kit in

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[84] Block E, Sustainment Block 10, 11, and 12, and 500-pound JDAM capabilities and modification were all installed after OIF and completed by 2006. ASC Block E upgrade briefing. Colonels Gary "Gordo" Mausolf, James "Hook" Pryor, David "Gunny" Been, and Kirk "Grinch" Hunsaker, interviews by the author, January to April 2010. Each colonel commanded a B-1 squadron during deployed operations after 2003.

[85] Colonels Gary "Gordo" Mausolf, James "Hook" Pryor, David "Gunny" Been, and Kirk "Grinch" Hunsaker, interviews by the author, January to April 2010.

September 2006, five years after it began the third phase of the CMUP.[86] The Block E upgrade replaced six 1970s-era computers with four Pentium speed units which provided a 25-fold increase in throughput, memory, and input/output margins for conventional weapons capability, defensive systems upgrades, and future growth. The upgrade also integrated the Wind-Corrected Munitions Dispenser, the Joint Standoff Weapons, and the Joint Air-to-Surface Standoff Missile, which substantially augmented the bomber's precision and stand-off weapons capabilities.

The new Block E offensive avionics eased the WSO's tasks in-flight. He could now allocate and assign targets to the correct weapons stations automatically, and the avionics system also offered a built-in pattern management capability. Additionally, the new Joint Programmable Fuse, JPF-152, integrated with the aircraft offensive avionics software let the WSO select any fuse combination on any weapon when aircrew needed specific weapon effects. Perhaps most significantly, the Block E upgrade included the ability to carry the new 500-pound JDAM. The smaller weapon provided more weapons-effects options for close air support scenarios where troops were too close to the enemy or collateral damage concerns precluded using the 2000-pound JDAM. For many experienced B-1 commanders, the combined weapons, avionics, communications, and situational awareness upgrades on the aircraft by 2006 made it seem like an entirely new strike platform than it had been in 1998.

Years after the fall of the Taliban the American military changed its strategy in Afghanistan, and new strategic measures of effectiveness would assess weapon systems like the B-1. The focus on counter-insurgency tactics increased, and the need for multiple simultaneous weapons releases using bomb-on-coordinate procedures decreased. The weapon system was now tasked to conduct more intelligence, surveillance and reconnaissance (ISR) missions, and armed reconnaissance, to provide an eyes-over-the horizon capability and security for ground forces who were struggling to win the hearts and minds of the Afghanistan people.

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[86] Boeing Co. "Boeing Completes Block E Avionics Upgrade of B-1 Bomber Fleet," 27 September 2006. http://www.boeing.com/news/releases/2006/q3/060927d_nr.html, accessed on 3 March 2010.

The mission changes underway were not as significant as when the B-1 transformed from a nuclear bomber to a conventional bomber, however, they had an immediate effect on operations. The weapon system still performed on-call close air support throughout all regions of Afghanistan, but aircrews were more frequently asked to perform ISR missions or conduct 'presence' orbits over development projects and areas that ground forces were monitoring for enemy activity. One tactic developed early on in OEF, which continued to be effective as a non-kinetic option during armed reconnaissance missions, was the low-altitude show-of-force (SOF) or medium-altitude show-of-presence (SOP). When employed sparingly, these non-kinetic responses effectively diffused tense situations between Coalition forces and anti-coalition forces when the risk of fratricide was too high to use conventional weapons.[87] Depending on the mission and the assumed threat levels, aircrews and the ground forces they supported determined the response necessary in each area and for each mission. Some situations required a kinetic response (dropping munitions), at other times, a show of force or a show of presence was all that was needed to support the ground element with airpower.

In one instance, a crew was tasked to provide close air support for troops-in-contact with the enemy. The crew reported they could hear AK-47s in the background radio noise as the JTAC yelled "I need a show of force NOW!"[88] The Taliban had closed in on and engaged US and coalition forces from two sides; the enemy was so close that the JTAC believed it was too dangerous to employ weapons. The B-1 aircrew performed a show of force that scared the Taliban enough that they pulled back into a tree line, increasing their distance from the JTAC enough for him to call in an airstrike from the same B-1.[89] Although the B-1 successfully supported troops-in-contact in this and many

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[87] Colonel Gary Mausolf, former 37 EBS/CC and 34 EBS/DO during 2003-2005 OEF/OIF, interview by the author on 10 Mar 2010, and email correspondence to author, 12, March 2010.
[88] Senior Airman Clark Staehle, "B-1 Crews Excel at Shows of Presence," 3 September 2007, 379th AEW PA, U.S. Air Force website, accessed at http://www.af.mil/news/story.asp?id=123063305. On 9 Mar 2010.
[89] Senior Airman Clark Staehle, "B-1 Crews Excel at Shows of Presence," 3 September 2007, 379th AEW PA, U.S. Air Force website, accessed at http://www.af.mil/news/story.asp?id=123063305. On 9 Mar 2010.

other situations, the B-1 could have been more effective if it had an onboard optical sensor to locate and identify targets to support ground forces.

General Gary North assessed his airpower needs immediately after taking command of Air Forces Central (AFCENT) in 2006 and found that he needed more persistent, accurate, and lethal armed reconnaissance in Afghanistan and Iraq. He recognized that B-1 modifications could give it "the same sensor technology as the rest of [my] fighter and RPV aircraft"—the B-1 needed an electro-optical and infrared (EO/IR) capable targeting pod.[90] General North understood that ground forces relied on the full motion video from EO/IR sensors, found on most Air Force fighter and attack aircraft, in their struggle to detect and protect themselves in the midst of counter-insurgency warfare. Although the B-1 performed successfully in the early stages of OEF using GPS-aided weapons and its high-fidelity radar for bomb-on-coordinate employment, it did not have an on-board sensor capable of providing effective ISR support.

Requests from the B-1 community for a targeting pod were not new. Brigadier General Wilson pitched the need for an EO/IR targeting pod to ACC as early as 1998, and again following Operation Allied Force on 1999; the response was always cold. The bomber could not gain support for a targeting pod in the midst of a long line of fighter program managers also waiting for funding for the next advanced targeting pod upgrades on their fleet of fighter aircraft.[91] Many at ACC and throughout the Air Force considered that targeting pods belonged on fighter aircraft. Every B-1 unit deployed since early in OEF and during each subsequent rotational deployment to OEF and OIF recognized the system needed an EO/IR targeting capability, as manifest through combat mission needs statements and "Lessons Learned" briefings at weapons and tactics conferences. Despite their efforts to document the need, there never seemed to be enough support or momentum for ACC to fund and support the concept

Despite frequent requests, the Air Force did not sanction a pod for the B-1 until General North assumed command of AFCENT in 2006. North

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[90] General Gary L. North, interview by the author, 16 March 2010. EO/IR is electro optical or Infrared.
[91] Brig Gen Stephen "Seve" Wilson, 379 AEW/CC, interview by the author, 25 March 2010.

declared his top AFCENT priority was putting a targeting pod on the B-1.[92] Rapidly procuring and integrating the advanced targeting pod sensor for the B-1, he believed, would be an important element in the fight in Afghanistan; he called it a "key enabler in winning the fight against an asymmetric enemy."[93] North recognized that coalition ground forces required airborne assets to monitor the surrounding terrain for imminent threats as friendly forces moved throughout the country. He argued that ground commanders did not need a specific type of aircraft to deliver airpower effects in Afghanistan or Iraq; they needed specific weapons and sensor capabilities or effects. He understood that the electro-optical and infrared sensors on the Sniper Advanced Targeting Pod would allow the B-1 to provide targeting and ISR support to ground troops from miles away.[94] More importantly, the Sniper pod could provide a video downlink to send a full-motion video picture of the battlefield space to the ground controller's laptop or handheld device, thus streamlining communication and shortening the timeline for a ground commander or JTAC to correlate the information seen by the aircrew.[95]

North asked Air Combat Command to modify the B-1 by installing a targeting pod as soon as possible. Despite not supporting similar requests in the past, once the Air Staff and ACC understood that the Air Component Commander placed such a high priority on that particular combat mission needs statement, momentum and traction were no longer a problem.[96] Implementing a solution was not quite as easy. Ultimately, the quickest solution to getting the targeting pod fielded turned out to be very non-traditional and unprecedented.

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[92] General Gary L. North, interview by the author, 16 March 2010.
[93] General Gary L. North, B-1 talking points paper emailed to the author from North's staff prior to video teleconference with the author on 16 March 2010. The Sniper ATP, a long-range precision targeting system, provides enhanced target identification for aircrew, allowing them to detect and analyze targets on the ground via real-time imagery.
[94] From North's perspective the JDAM and ROVER full motion video (FMV) capabilities delivered at the request of ground forces were the same from the B-1 as they were from any type of aircraft.
[95] As earlier referenced, ROVER is the technology that provides FMV and downlink capability to ground forces with compatible equipment.
[96] Col Chris "Jekyl" Brunner, interview by the author, 4 March 2010.

The modification first required international treaty approval. Regulations implemented by the Strategic Arms Reduction Treaty (START), between the United States and the USSR had prevented the B-1 community from installing a targeting pod earlier.[97] The START II treaty had to be amended so the B-1 could carry anything on its external stores pylon fittings. Typically, targeting pods were attached to aircraft munitions pylons or special fittings attached to the aircraft fuselage. In order for a pod to be secured to the B-1, a specially built pylon was built and attached to the fuselage external stores fittings, which had to be modified to attach the targeting pod. To meet the demands of the new START treaty amendment, engineers had to show that the external hard points carrying the targeting pod pylon could never accommodate a nuclear weapon.

After amending the treaty, the B-1 community needed to quickly field a technical solution. One idea was an adaptation made possible by the 'Grumpy Jet' modification on the aircraft. Using the laptop computer system developed by the aircrew in 2001, engineers designed customized software and hardware to control a Sniper advanced targeting pod. The modification, called the Lap Top Controlled Targeting Pod (LCTP), consisted of a single laptop between the two aft WSO stations, and a networked laptop and repeater screen mounted between the pilot and co-pilot stations on the glare-shield display. The design was only partially integrated with the B-1 offensive avionics radar and weapons, but it provided a rapid and fully capable EO/IR sensor system for the aircrew to perform the ISR and armed reconnaissance missions. It could also be fielded three times faster than any other SPO-recommended alternative.[98]

Once the concerns with satisfying START treaty constraints and flight engineering design requirements were met, the modification and software design program proceeded rapidly.[99] The B-1 SPO, under the direction of ASC,

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[97] "As a part of the START, B-1s were classified as no longer nuclear capable and we were not authorized to use the exterior of the aircraft to mount pods," said Lt. Col. Kevin Kennedy, 34th Expeditionary Bomb Squadron commander. "We had to get approval to mount the pods on the exterior of the aircraft."

[98] From CFACC request to first combat mission was approximately 18 months.

[99] Col Chris Brunner, interview by the author, 4 March 2010. Col Brunner worked on Air Staff in 2003-2006 and prepared the START treaty approval along with OSD over a two year period. He was also the 337th TES/CC who worked with Boeing during the demonstration and capability flight which made General North aware of the laptop controlled targeting pod capability.

adapted the aircrew laptop modification for certified use and integration with the advanced targeting pod.[100] The Boeing Company had already built a test pylon customized for the B-1 and fitted it to carry a Sniper XR targeting pod. In fact, Boeing had flown a demonstration flight earlier in 2006 to show the feasibility of rapidly modifying the B-1 with a targeting pod. To fit the pod for the B-1, the aircraft's hard points had to be modified to carry the pylon and the Sniper targeting pod. Extensive electrical and aviation modifications were also needed so the Sniper pod could integrate with existing avionics. The 337th Test and Evaluation Squadron worked closely with Edwards AFB developmental test units to complete flight-testing and train B-1 aircrews. Less than nineteen months after General North asked for a targeting pod, B-1 aircrews flew combat missions with the new capability.[101] With the targeting pod capability, the B-1 became a key element of the Find-Fix-Target-Track-Engage-Assess CONOPS used extensively in all operations in Afghanistan and Iraq.

In 2008, airstrikes in Afghanistan were at their peak in terms of weapons being dropped against anti-coalition forces, the United States released 587,000 pounds of ordinance in June and July alone, which was as much as was dropped in all of 2006. The B-1 contributed significantly to those numbers in Afghanistan but also flew missions in Iraq on occasion to support unique requirements. One unique mission that was flown in a Block E aircraft, prior to the targeting pod modification, occurred when a B-1 crew was tasked to destroy an al Qaeda torture compound and prison with six 500-pound JDAM.[102] The airstrike was a joint coordinated effort with Multi-National Division Center forces and Iraqi forces.[103] It was designed to show the local villagers, many of whom had been tortured in the facility, that all remnants of al Qaeda in their area were gone according to Army LTC Mark Soloman. After the strike, as

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[100] Major Danny Slifer, 419th Flight Test Engineer at Edwards AFB, interview by the author, 11 April 2010.
[101] Boeing, "Boeing Demonstrates Increased Capabilities on B-1 Bomber," St. Louis, 6 Feb. 2007. http://www.boeing.com/news/releases/2007/q1/070206b .nr.html.
[102] Tech Sgt Joel Langton, "B-1 Destroys al-Qaida Torture Compound in Iraq," Air Forces Central Public Affairs, US Air Force official site. http://www.af.mil/news/story/asp?id=123089666.
[103] Officials from the Multi-National Division-Center, the Combined Forces Air Component commander's Air Operations Center, the 379th Air Expeditionary Task Forces Air Expeditionary Wing, and Sons of Iraq, who helped provide security, participated in the mission.

coalition members left the area, villagers stood on the side of the road cheering and clapping to be rid of what they referred to as an evil memory. The B-1 appeared to be successful in every aspect of supporting the US and coalition airpower strategy. By July of that same year, the 34th Bomb Squadron was the first squadron to deploy with the Sniper ATP targeting pod modification, one month later, a Sniper ATP equipped B-1 had its first weapon employment in combat, successfully targeting enemy forces on the ground and dropping one GBU-38.[104]

The B-1 continued to perform well through the beginning part of 2009 using the new targeting pod to enhance its close-air-support and armed reconnaissance missions. However, in May of 2009, an unintended accident involving strike aircraft caused significant collateral damage. A B-1 and a pair of F/A-18Fs, tasked to support a group of Marines and Afghan soldiers, engaged in a firefight with militants in the Farah province. The Taliban were hunkered down in an area with a significant civilian population. Over the course of the standoff, three 2,000-pound JDAM and five 500-pound JDAM were dropped on buildings the aircrew believed were emptied of non-combatants—they were not.[105] Following the incident, President Obama promised to "make every effort to avoid civilian casualties" in the future. Later that month, he named General Stanley McChrystal as the new commander for the Afghanistan war.[106]

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[104] Capt Kristen Pate, "Sniper ATP-equipped B-1 has Combat First." 379th Air Expeditionary Wing Public Affairs, Air Force Official Website. http://www.af.mil/news/story.asp?id=123110313 . The deployment involved a lot of preparation training. The 34th EBS, deployed from Ellsworth Air Force Base, SD, only recently arrived at the 379th Air Expeditionary Wing. Prior to their deployment, pilots, WSOs and maintenance personnel received required training on the Sniper ATP, which was installed on the B-1 in April. "The training requirement was significant because it took place during our regular spin-up time prior to the deployment," Colonel Kennedy said. "For aircrew, the training involved approximately 10 to 12 hours of academics, three flights for WSOs and two flights for pilots. When you're talking 50 crewmembers flying the same three aircraft, this is a challenge."

[105] Noah Shachtman,, "How The Afghanistan Air War Got Stuck In The Sky," *Wired Magazine*, 8 December 2009. http://www.wired.com/magazine/2009/12/ff._end_air_war_all_1.

[106] Noah Shachtman,, "How the Afghanistan Air War Got Stuck in the Sky," *Wired Magazine*, 8 December 2009. http://www.wired.com/magazine/2009/12/ff._end_air_war_all_1.

In July of 2009, McChrystal, the senior NATO commander in Afghanistan directed that all air strikes be reduced as much as possible to reduce civilian casualties.[107] The directive required a radical shift in the approach within Afghanistan. For most of the first eight years of the war, the United States and NATO relied heavily on airpower to keep militants in check. This strategy relied on precision engagement, sophisticated targeting, and the omnipresence of airpower to minimize the number of troops required to wage the war.[108] The problem with this approach was that airstrikes, even when accurate, can alienate the support of the population—a critical factor in successful counter-insurgency campaigns. Gen McChrystal instructed commanders to authorize air-to-ground munitions, including bombs and small missiles, as well as indirect fires such as mortars and rockets, only under "very limited and prescribed conditions."[109] He also emphasized that commanders could use force, but only as a last resort to protect their troops.

General McChrystal's direction resulted in reducing CENTCOM's annual totals for close air support sorties in 2009 by 17 percent.[110] More importantly, the change in commander's intent resulted in much stricter rules of engagement (ROE), instructions that aircrew and JTACs are required to follow in combat. As the aircrew and the JTACs worked together to determine if an attack was needed, they had to ensure that strictly described ROE were met. General McChrystal's new guidance demanded that before a plane could drop a bomb, or make a strafing run, the pilot or JTAC had to visually identify an insurgent firing a weapon—no easy task from either the ground or the air. For the B-1, this was an impossible task prior to the aircraft modification adding the targeting pod.

General McChrystal's new strategy meant that, for most missions, strike aircraft were dedicated to non-traditional intelligence, surveillance and reconnaissance efforts supporting the movement of troops and security

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[107] Michael Hoffman, "Looking Down in Frustration: McChrystal order limiting Afghan airstrikes takes punch out of pilots," *Air Force Times*, 3 May 2010.
[108] Noah Shachtman, "How the Afghanistan Air War Got Stuck in the Sky," *Wired Magazine*, 8 December 2009. http://www.wired.com/magazine/2009/12/ff_end_air_war_all_1.
[109] Michael Hoffman, "Looking Down in Frustration," *Air Force Times*, 3 May 2010.
[110] Michael Hoffman, "Looking Down in Frustration," *Air Force Times*, 3 May 2010.

measures around population centers. The B-1 community responded to the new directive positively. One aircrew member interviewed recognized that every time a bomb kills an innocent civilian the war effort is set back, even if the strike also killed one-hundred enemy Taliban or al Qaeda.[111] The B-1 organization remained determined to continue being effective in their role, having the targeting pod enabled that effectiveness under the new guidelines for weapons employment set forth by McChrystal. Although the B-1 was still armed and ready to strike on any mission, it adapted to become an effective element in the strategy for Afghanistan with its new targeting pod available and by recognizing a new strategic objective in the NTISR mission.

As of December 2009, the B-1 weapon system had over 7,000 combat sorties and 80,000 combat hours over Afghanistan and Iraq, more than double that of all other bombers combined.[112] The weapon system had adapted to another type of warfare which involved flying long-duration, armed reconnaissance missions supporting the counter-insurgency strategy. Similar to the weapon system's conventional transformation in the 1990s, the B-1 needed the support of senior leaders to become effective in irregular war. The support from key leaders, General North in particular, generated momentum for innovation; it secured funding for technological modifications that ensured the aircraft remained effective in the irregular warfare role. The combined support of those senior combat leaders, with successful innovations in equipment and tactics generated by B-1 aircrew, opened the innovation window.

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[111] Capt Dave "Smoke" Grasso, quoted in Noah Shachtman, "How the Afghanistan Air War Got Stuck in the Sky," *Wired Magazine*, 8 December 2009. http://www.wired.com/magazine/2009/12/ff._end_air_war_all_1.

[112] Power Point FY10 Staffer Brief/ ACC in author's possession. B-1 Current Ops C-IED 1479 hrs, TICs 318, Armd Ovrwtch 1118.

CONCLUSION

LESSONS LEARNED

A strategy that would prepare military innovation for this new world has to focus on the management of uncertainty, rather than on the construction of new capabilities tailored to predictions of what future wars would look like.

—Stephen P. Rosen

Stephen Rosen's theory on innovation proposes questions concerning how and why military innovation takes place. The B-1 case study provides a textbook example to evaluate and apply Rosen's theory as an explanatory model, showing what enabled and what inhibited transforming the nuclear bomber into a formidable conventional weapon system, and then into a workhorse for irregular warfare. The B-1 experienced extensive organizational, technological, and doctrinal changes during its peacetime transformation; as a result, the weapon system developed the flexible and adaptable characteristics of a learning organization. In the process, the weapon system gained credibility within Air Combat Command, the newly consolidated combat arm of the Air Force. Then, as the entire Air Force abruptly entered an eight-year period of wartime operations, the B-1 weapon system's organizational, technological, and tactical changes continued, enabling its successful adaptation to the strategic measures of effectiveness in wartime. Rosen maintains that money alone does not spur innovation; talented military personnel, time, and information have been the key resources that both enable and inhibit change.[1] This examination of the B-1 weapon system has revealed many of the same lessons.

Rosen concludes that peacetime innovation occurs when senior military officers with traditional credentials react to structural changes in the security environment by creating a new promotion pathway for junior officers practicing a new way of war.[2] He then argues that wartime innovation, as opposed to reform, has been most effective when military units redefine their strategic measures of effectiveness. Since combat occurs in bursts of activity by the military organization, he claims wartime innovation is, hopefully, limited in

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[1] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, (Ithaca, NY: Cornell University, 1991), 252.
[2] Rosen, *Winning the Next War, 36.*

duration. Rosen places little faith in wartime learning and organizational change.[3] As for technology spurring military innovation, Rosen finds little evidence that militaries tailored the development of new technologies by understanding their potential enemy or reliably predicting the cost and utility of emerging technologies. Instead, the problems of choosing new technologies have proven best handled when treated as a matter of managing uncertainty.[4]

PEACETIME INNOVATION

Peacetime military innovation can be explained in terms of how military communities evaluate the future character of war, and how they effect change in the senior officer corps. An examination of the B-1 weapon system's transformation reveals that innovation during peacetime can be a very slow, challenging, and at times a frustrating process for those involved. General Loh and other Air Force leaders expended considerable energy, resources, and personal attention to sustain the process. When these leaders attracted, protected and promoted talented, young, highly promotable officers to a new way of war, they were able to produce new, usable military capabilities. Just as Rosen concludes, senior Air Force officers formulated a strategy for innovation with both intellectual and organizational components to transform the B-1 weapon system. Organizationally, the Air Force had to integrate the weapon system and its units possessing a strong SAC heritage into its new combat air arm, Air Combat Command. The intellectual component of innovation occurred as the B-1 was integrated into Air Force conventional warfare employment and training methods, such as the weapons school, Red Flag, and the composite wing. This fostered a new culture within the B-1 that developed and enabled new tactics, technology, and learning characteristics.

Reacting to a major change in the nation's security environment, namely the end of the end of the Cold War, Air Force leaders made organizational changes to their main combat arms.[5] General McPeak integrated his two combat air arms, Strategic Air Command and Tactical Air Command, into a single combat arm—Air Combat Command.

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[3] Rosen, *Winning the Next War*, 251.
[4] Rosen, *Winning the Next War*, 252.
[5] Rosen, *Winning the Next War*, 52.

With the end of the Cold War, General Loh also recommended restructuring the nation's bomber force by retiring all but the newest B-52 bombers. General McPeak approved this major organizational restructuring, but it created a gap in the nation's conventional striking ability. General Loh envisioned filling this targeting gap in conventional long-range strike capabilities by transforming the B-1 weapon system, through the conventional munitions upgrade program, to become the backbone of the nation's conventional bomber force. McPeak supported General Loh's recommendations to restructure the bomber force by retiring all B-52 models, except the newest B-52Hs, and enhancing the B-1B. Loh's strategic vision for the B-1 was the catalyst for the conventional transformation of the weapon system, enabling it to fill the targeting gap left in conventional long-range strike capabilities and to become the backbone of the conventional bomber force.

Through integration with the Air Force Weapons School and other combat training elements, such as Red Flag and the composite wing at Mountain Home AFB, the Air Force opened a new intellectual pathway for B-1 officers. Gen Loh's strategic vision for B-1 conventional training integration fostered a new promotion pathway for bomber officers who excelled as conventional tactics warfighters. These former Strategic Air Command officers, in particular specially selected B-1 aviators, were given a promotion pathway and allowed to develop as future squadron, group, and wing commanders responsible for meeting the objectives, tasks, and missions of the new B-1 conventional way of war within Air Combat Command. The B-1 selection process in general involved a specialized selection board, and the integration and selection for promising officers to attend the weapons school was the same. Each opened the pathway for "talented young officers with great potential" to practice the conventional "new way of war."[6]

WARTIME INNOVATION

Wartime innovation is related to the development of new measures of strategic effectiveness, effective intelligence collection, and an organization able to implement the innovation within the relatively short time of a war's

[6] Rosen, *Winning the Next War*, 252.

duration.[7] Rosen argues that military organizations change or alter their behavior during wartime in two distinctive ways.[8] Using the first approach, military units learn within the context of existing military missions. Routine military intelligence and "feedback" help wartime organizations learn and better execute their established missions.[9] Rosen does not classify such improvement in proficiency as innovative.[10] Furthermore, Rosen considers organizational learning and innovation extremely challenging during wartime. He concludes that the need for wartime innovation exists when improving an existing mission's performance only makes the strategic situation worse; it is then that a new mission for a combat arm must be invented in order to achieve victory.[11] He characterizes reform during wartime as times when military organizations experience reverses or failures, which compel them to change their behavior.[12] If, however, a wartime problem occurs that falls outside the parameters of established missions and concepts of operation, and pursuit of existing performance goals only makes the problem worse, requiring completely new capabilities, then innovation is necessary. An innovation will involve new organizational tasks and concepts of operations. The strategic goal, or the relationship of military operations to a goal, and the indicators of how well operations are proceeding toward that goal, are described by Rosen as strategic measures of effectiveness for the military organization. He states that if an appropriate strategic measure of effectiveness is in place, information can be collected that is relevant to that measure, so that organizational learning leading to reform can take place.

Innovation, rather than reform, may be required in wartime when the old ways of war are not helping the military win the war. This situation can arise, according to Rosen, when inappropriate strategic goals are being measured or the relationship between military operations and strategic goals are

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[7] Rosen, *Winning the Next War*, 52.
[8] Rosen, *Winning the Next War*, 27.
[9] Rosen, *Winning the Next War*, 253.
[10] Rosen, *Winning the Next War*, 27.
[11] Rosen derives this distinction from the views of two theoreticians who addressed the specific problem of learning in war and from one of the best developed theories of organizational learning and change, the cybernetic model of decision-making. Rosen, *Winning the Next War*, 27.
[12] Rosen, *Winning the Next War*, 30.

misunderstood.[13] The traditional and established ways of war are employed but the war is not being won—requiring innovation. Military organizations facing the need to innovate during wartime must first assess conditions, invent new measures of effectiveness, and craft an innovative organizational response--all within the few years of active combat. Clausewitz's concepts of fog and friction in war helps describe Rosen's observation about the difficulty of innovating during wartime. Rosen suggests that wartime innovation is extremely difficult for even the most disciplined and capable military organization.[14]

In early 2001 and 2002, B-1 squadrons were prepared organizationally and culturally to transition rapidly into wartime operations; they otherwise could not have performed as successfully as was reported in the initial deployment and combat operations in Afghanistan or Iraq. The tactical changes made after the initial engagement with the enemy improved the weapon system's performance and its ability to execute the assigned mission.

The tactical changes and ideas stemming from innovative airmen in the B-1 community eventually initiated an innovation that evolved to a point where it provided a "strategically useful option," and would characterize Rosen's idea of what should indeed be considered innovation. [15] The 'Grumpy Jet' laptop computer modification was relatively inexpensive, developed at the grassroots level by aviators, and the key enabling capability to modify the aircraft with the Laptop Controlled Targeting Pod using the Sniper XR system. This new technology allowed the B-1 to remain relevant in the counter-insurgency efforts in Afghanistan, even after General McChrystal changed the strategy and methods of employment for airpower missions over Afghanistan. Furthermore, the 'Grumpy Jet' modification assisted B-1 aircrews in achieving better results

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[13] Rosen, *Winning the Next War,* 35.
[14] Rosen, *Winning the Next War*, 38.
[15] The "Grumpy Jet" laptop computer modification eventually led to the ability for the SPO to integrate the targeting pod on the B-1. Rosen stated that wartime innovation, even when successful, was less dramatic than in peacetime because of the lack of time for a more thoroughgoing implementation. Reformulating strategic measures of effectiveness was associated with allocation of scarce resources. He further states that wartime innovation involving reformulations of concepts of operations and resource allocations must proceed from the top down. This helps explain why it took the highest ranking airman in CENTCOM to direct the expensive development of the targeting pod on the B-1.

when the strategic measures of effectiveness changed throughout the different periods of GWOT. The modification confirms Rosen's assertion that wartime innovation is most successful when it is associated with decentralized control of operations or a decentralized capability to modify equipment in the field in response to enemy tactics.[16]

TECHNOLOGICAL INNOVATION

Rosen provides an argument for technological innovation centered on the question of whether military demand pulled new technologies, or whether new scientific advancements pushed technological innovations. He also questions whether military intelligence plays a shaping role in technological innovation. He also introduces the problem facing modern militaries as they try to develop new technologies while evaluating the costs and benefits of new weapons. He concludes that when choosing new military technologies, a strategy has to account for the extreme difficulty of reaching any conclusive analysis of the prospective cost and utility of alternative development programs. Military research and development decisions are made amid uncertainties about future war according to Rosen.[17] Since the future is uncertain, Rosen concludes that the strategy for technological innovation should be to seek as much flexibility as possible in new weapon systems rather than trying to buy the one weapon that will perform best if built to specifications, at expected cost; and that eventually will emerge as the strategic weapon needed for a future conflict.[18]

New technological capabilities played a significant role in the B-1 weapon system's transformation, both during peacetime and in wartime. The peacetime technological modifications helped Air Force leaders manage uncertainty because they made the weapon system more flexible and adaptable, instead of

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[16] The study of wartime innovation showed that under certain circumstances, wartime innovation played a larger role in reformulating strategic conceptions, and affecting the outcome of war when associated with "extremely" decentralized control of operations, or a decentralized capability to modify equipment in the field in response to enemy tactics. Ordinarily though, according to Rosen, large military organizations are centrally directed and reformulations in their concepts of operations and resource allocations must proceed from the top down. Strategic intelligence also tends to be analyzed at the top, even when control of operations is decentralized. Rosen, *Winning the Next War*, 253.

[17] Rosen, *Winning the Next War*, 221.

[18] Rosen, *Winning the Next War*, 244.

focusing narrowly on an anticipated adversary or operational scenario. This same flexibility, along with the flexible organizational traits the B-1 community gained from comprehensive training, enabled innovative ideas and solutions for the B-1 community.

The B-1 case study reveals the level of flexibility required of a weapon system to make innovative changes. Once the innovative ideas, such as the laptop computer system and the laptop-controlled targeting pod reached Generals Jumper, Moseley and North, they were able to integrate them into combat strategies. General North knew immediately upon taking command that technological changes were needed in the B-1 in order to support the ground force commander's COIN strategy. As a result, the B-1 was modified within 18 months to use the most advanced targeting pod available. Engineers designed the software and hardware to integrate with the B-1 radar through the laptop computer interface—the roots of which grew out of the innovative ideas of B-1 aircrew who developed the laptop modifications on the aircraft. The push to innovate in the B-1 gained the support of senior leaders as new ideas and solutions emerged from the ground-up, at the grassroots level of the organization. Eventually the institution responded to those ideas with permanent technological solutions and funding.

The technological changes in the B-1 during wartime were twofold. Significant weapons and aircraft block upgrades were implemented after 2001; secondly, there were significant non-sustainment upgrades such as the laptop-computers with charts and imagery, the pattern-management software, and then the laptop-controlled targeting pod. Some small improvements, largely limited to situational awareness enhancements on the open architecture of the laptop computers, were also made. The innovations needing extensive engineering and resource allocations required a centrally controlled, top-down key-leader support mechanism, and then time to implement the solution. Although the war in Afghanistan has been going on for over eight years, technological upgrades that came to fruition during the war were begun many years in advance, with one exception, the laptop-controlled targeting pod. That singular technological and wartime innovation enabled the system's successful

adaptation to the new strategic objective under General McChrystal's limited-kinetic-response ROE.

LESSONS LEARNED

Rosen contends that talented military personnel, time, and information have been the key resources for innovation. The push to innovate in the B-1 weapon system gained momentum because of the influence and vision of senior leaders, while the solutions or tactical ideas for new methods of warfare using the B-1 emerged from the grassroots level of the community—eventually the institution responded to those ideas with permanent technological solutions and funding. Although Rosen concludes that wartime innovation is less dramatic because of the lack of time for a more thorough implementation of an innovation, the B--1 case study shows that significant technological changes and adaptations in mission objectives do occur, but they rely on peacetime acquisition mechanisms for their support.

The concluding lesson is that wartime organizations must be healthy, learning and flexible organizations, eager to be successful in any mission in order to spawn wartime innovation. Wartime opens up more opportunities for program funding for new technologies, which makes innovation more likely and quicker. Peacetime funding for innovation, on the other hand, is extremely competitive as each sub-component of a combat arm strives to gain approval for its individual projects. Wartime tends to make more funds available for weapon systems that are supporting combat priorities.

The B-1's successful transformation relied upon a combination of peacetime and wartime innovations. Without the foundation of the peacetime innovations in the B-1, the laptop-controlled targeting pod would not have been possible or relevant. The Block D upgrade included a MIL-STD 1760 data bus and precision weapons, improved Voice Satellite, and secure radio capability. Finally, the upgrade improved the system's self-protect capability with the towed decoy that prepared the aircraft for Allied Force and OEF/OIF. Also, defense contractors were conduits for new, innovative ideas when they provided expertise when modifications were underway. Each of the pattern-

management, laptop-controlled targeting pod, and large-block upgrades were completed with the support of companies that retained a high level of corporate knowledge and experience with the aircraft, thereby making quick wartime upgrades possible.

As the mission changed to a COIN strategy, focusing less on using kinetic weapons to kill insurgents and more on supporting the ground elements through non-traditional ISR roles, the B-1 weapon system altered its tools and procedures to perform the mission.[19] This completes a migration of missions across the entire spectrum of warfare, from nuclear bomber, to conventional platform, to a supporting role in irregular warfare.

[19] United States Department of the Army, *The U.S. Army and Marine Corps: Counterinsurgency Field Manual*, (University of Chicago Press, 2007), 367.

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